THE ENGINEER

A Seven-Day Journal

B.I.C.E.R.A. Annual Report

The annual report for 1950 of the British Internal Combustion Engine Research Association has just been issued. It gives the terms of the Government grant to the Association for the five-year period 1950 to 1955, and emphasises the need for an expanded industrial income to meet the conditions laid down. The report of the research committee contains brief summaries of thirty-one items in seven main groups. The Association's general research deals with fuel injection and rating tests, the use of heavily leaded petrol, the fatigue of cast iron crankshafts, bearing performance, and the development of instrument, a final section being devoted to foreign engines. Torsional vibration forms the main subject of the second group, including torsional stiffness of crankshafts, couplings and driven machines, moments of inertia of marine propellers, harmonic components of two-stroke cycle engines, vibration amplitudes and flexural vibration of shafts and the performance of dampers. The pressure-charging panel has reported upon pressure chargers and the pressure charging of engines, including analysis methods, while the gas turbine advisory panel has made brief mention of rotary gas turbine installations. It is stated that a report is in preparation concerning piston gas generators, and there is also a reference to the preparation by the British Standards Institution of a glossary of standard terms. The next group of research reports is concerned with noise reduction and discusses instrumentation, the various noise tests and the possible formulation of a standard of measurement for commercial purposes, and measurement of noise generated by engine components. A combustion, fuels and lubricants panel has investigated the combustion processes of compression-ignition engines, and states that a report is complete. Finally, the report gives a list of research items associated with the work of the Motor Industry Research Association.

Institute of Marine Engineers

On Tuesday evening last, Dr. S. F. Dorey, C.B.E., F.R.S., delivered his presidential address to the Institute of Marine Engineers, taking as his subject "Science and the Marine Engineer." He recalled that marine engineering as a branch of mechanical engineering was 150 years old, and that it owed its origin to the double-acting engine of James Watt. Science played a part in that the phenomenon of latent heat influenced Watt, and improved materials helped to increase confidence in steam engines. In the early days, Dr. Dorey continued, the advances in science were largely physical, but many eminent engineers carried out pioneer experimental research. The contributions of Joule, Carnot and Rankine to the founding of the science of thermodynamics were mentioned, and the President suggested that the wider scientific approach to problems called for more technical education, together with the establishment of rules for the training of engineers. Dr. Dorey recalled that a research committee was formed in 1879 and that the advent of Siemens-Martin steel was followed by higher steam pressures, greater piston speeds and reduced coal consumption. In 1889, when the Institute of Marine Engineers was founded, many developments were approaching, including the use of water-tube boilers, the advent of steam turbines, the first heavy oil engine, and the beginnings of electricity. The steam reciprocating engine was at its zenith in 1900, Dr. Dorey said, and the rapid advances in steam pressure and in other fields called for greater attention to the testing of materials and the development by the metallurgist of improved ferrous and non-ferrous metals. The address briefly mentioned the present position of steam turbine machinery, the popularity of the oil engine, and the large number of modern aids for testing materials and for recording measurements of physical phenomena. Talking about the future, Dr. Dorey referred to the need for improved materials for boilers and superheater tubes, and the problems related to the use of nuclear energy. He then went on to say that the effect of the increasing application of science meant specialisation, for only the ablest could deal with a number of subjects on a high level, and, therefore, the grading of technical education and training of marine engineers was of foremost importance.

Netherlands—Denmark Submarine Cable Link

On Friday last, the new Netherlands–Denmark telephone communication system was officially opened at The Hague and in Copenhagen. In 1948 the Netherlands and Danish Post, Telegraphs and Telephones Administration decided that the system should include duplicate submarine cables which should be laid between Oostmahorn, on the Netherlands north coast, and the Danish island, Romo. The shore ends were laid first by the Danish and Netherlands cable ships, "Krarup" and "Poolster," respectively in July and August, 1950, namely, 16 miles at Romo and 28 miles at Oostmahorn, while 6 miles of cable were installed across the island of Romo. With the help of the naval authorities, a channel a mile wide was swept clear of mines so that Submarine Cables, Ltd., could lay two cables half a mile apart. The work of laying the cable was carried out by H.M.T.S. "Monarch," chartered from the British Post Office, and the main cable was spliced to the Romo shore end in August and to the shore end at Oostmahorn in September of last year. The terminal equipment and submerged repeaters were the responsibility of Standard Telephones and Cables, Ltd., and in each cable two submerged repeaters were inserted during the laying operations. One was placed some 62 nautical miles from Romo, and the other 40 nautical miles further away, so that the cable is divided into three sections having lengths of 62, 40 and 40 nautical miles. The cables, which are the largest solid dielectric submarine coaxial cables yet laid, each provide for thirty-six telephone circuits, though greatly increased traffic capacity can be provided by installing more submerged repeaters.

The Training of a Technologist

The Redwood Lecture to the Institute of Petroleum was delivered in London on Wednesday evening by Professor F. H. Garner, Director of the Chemical Engineering Department at Birmingham University. The lecture dealt with the education and training of the technologist. In the course of it, Professor Garner said that most scientists would agree that some knowledge of the humanities should be included in their training, though by no means all humanists considered that a knowledge of science should figure in their training! In addition to some knowledge of the arts, Professor Garner suggested, a technologist needed special personal qualities of leadership, which could only be gained by personal contacts. Dealing with the broader aspects of training, Professor Garner refuted the idea that applied sciences were out of place in a university and that modern engineering education consisted of a series of "snippets" of subjects with no real grounding in any branch of science whatever. For a successful university training, he considered that the technologist required a fuller series of lectures, tutorial and practical classes than were necessary for an arts student. They must be so directed that they led to the development of the potentialities of the personalities of individual students. Professor Garner agreed that the "knowhow" of industry could only be acquired in industry itself, but, he asserted, the teaching of why different techniques were used and the principles on which they were based could well be given at the university, contact with industry at home and abroad being maintained through vacation courses. Finally, Professor Garner expressed the hope that graduate schools, for so long an integral part of technological training in the U.S.A., might soon be firmly established in this country.

A C.P.R. Appointment

The Canadian Pacific Railway has announced that Mr. R. A. Emerson, of Montreal, assumed office on October 1st as chief engineer, in succession to Mr. J. E. Armstrong, who has retired after thirty-nine years' service with the company. Mr. Emerson comes from a railway family, as his grandfather, father and mother were all in the service of the C.P.R. He joined the company in 1935 in British Columbia, after graduating at the University of Manitoba. Mr. Armstrong has been in railway service for over fifty years. He joined the C.P.R. in 1912 as assistant engineer at Montreal, and succeeded to the position of chief engineer in 1939. He is a past-president of the Engineering Institute of Canada, the American Railway Association, and the Canadian Railway Club of Montreal.

Radio Rearmament Advisory Committee

Towards the end of July, the Minister of Supply, Mr. G. R. Strauss, said in Parliament that it was his intention to set up a radio rearmament advisory committee, the main purpose of which would be to enable the Ministry to discuss defence matters with the radio industry. At the end of last week it was announced that the following had agreed to serve on the committee as the radio industry's representatives:—Mr. A. G. Clark, of the Plessey Company, Ltd.; Mr. L. T. Hinton, of Standard Telephones and Cables, Ltd.; Mr. M. M. McQueen, of the General Electric Company, Ltd.; Mr. F. S. Mockford, of Marconi's Wireless Telegraph Company, Ltd.; Mr. E. J. Power, of Murphy Radio, Ltd.; Mr. J. W. Ridgeway, of Edison Swan Electric Company, Ltd.; Mr. E. E. Rosen, of Ultra Electric, Ltd.; and Mr. C. O. Stanley, of Pye, Ltd.

The College of Aeronautics

The Board of Governors of the College of Aeronautics, Cranfield, Bucks, has created a new post of Professor of Mathematics in the Department of Aerodynamics. Mr. G. N. Ward, M.A., has been appointed to this chair and is expected to take up his duties in December next. Professor Ward read for the Mechanical Sciences Tripos at Cambridge and during the last war was engaged in research work for the Admiralty at H.M. Anti-Submarine Experimental Establishment. Towards the end of the war he was seconded to the Ministry of Supply for work on high-speed aerodynamics. In 1946 he was appointed to an I.C.I. research fellowship at Manchester University, and is at present a Senior Lecturer in Mathematics at that University. Professor Ward is the author of several research reports and other papers on aerodynamics and mathematical applications.

An Overseas Engineer at the Festival of Britain

(Contributed)

ANY engineer visiting the various exhibitions of the Festival of Britain must have been continually aware of the need for sudden adjustments of focus or manipulations of his scale of values. Suppose, for instance, that he stands in the middle of the Hungerford foot-bridge, facing down-stream, looking forward and to the left, he sees the tall buildings of the Embankment, the avenues of trees in front of them, the spacious Thames and the austere lines of Waterloo Bridge: these form a composition that he feels to be harmonious, satisfying and inspired by a proper air of metropolitan dignity. When the observer turns to the right the scene is pitched in quite a different key: apart from the Royal Festival Hall and the Dome of Discovery, everything suggests—as it is meant to suggest—gaiety, fantasy and impermanence. Another kind of dualism is forced upon the observer if he should be an expatriate Englishman just returned from overseas. Shall he play the part of a foreign visitor, praising when he can and guarding a polite silence when he cannot: or shall he accept, with his British nationality, some share of responsibility for the exhibitions and thereby earn the right to say just what he thinks about them?

But if absolute standards may waver, there are plenty of opportunities for comparative judgments. How does the 1951 Festival compare with, say, the exhibitions at the White City in 1908, at Wembley in 1924, or at Glasgow in 1938? Or, again, if anyone were to be persevering enough to go to all the major displays this summer—the South Bank, the Pleasure Gardens, the exhibition of "live architecture" at Poplar, the science exhibition at South Kensington, the exhibition of Industrial Power at Glasgow—would he find them of equal merit? Would any one of them seem to be outstanding? Could any common guiding principles be discerned? Of course, these questions are not difficult to answer. The 1951 exhibitions are basically distinct from earlier ones because a new principle informs them; instead of being a place where objects are on view, an exhibition is now to be regarded as a scene for the unfolding of a story. And who is the story-teller? Who is it who manipulates the objects—for there still are objects—into the pattern he has formed in his own mind? Whether or not a master-mind has been at work, the list of ministrants is formidable: the hierarchy of architects and designers and theme conveners and script-writers and display experts has the air of the list of "credit titles" we are accustomed to see on the cinema screen.

The effect on the visitor is immediate. He is always conscious of the invisible guiding hand—benevolent, doubtless, but certainly firm—and if he is not actually made to feel like "a being that moves in predestinate grooves," he finds it hard to recapture the carefree mood of bygone exhibitions. Naturally, he is made physically aware of the new aids to story-telling that the march of time and the march of science have put at the disposal of the exhibition creators. The mechanised or disembodied voice—one of the distinctive symbols of our age—was used with varying degrees of emphasis. It was undoubtedly very effective at one of the displays at the building exhibition at Poplar. In a nearly empty room, you heard first of all the sort of noises that would be likely to penetrate from the house next door if the party walls had been built without any regard to sound insulation; then, after listening to this harrowing sequence, you could assess the efforts of the sound-proofing consultant by observing how, in another sequence, the intrusive sounds had been damped down.

At the science exhibition at South Kensington there was an opportunity of judging how effective a vocal explanation could be, in conditions where technically the printed word would have served equally well. The subject-matter here was a carbon crystal under various degrees of magnification, ranging from the natural size in a moving piece of a lead pencil, up to a large diagram that attempted to show the structure of the atom. As the speaking voice was persuasive and well reproduced, and as the setting was quite permissibly dramatic, the combined result was highly successful. Perhaps it was at Glasgow that the eye and the ear were simultaneously attacked on the broadest front—and it really was a broad front, extending over fifty linear feet or more. In order to suggest the history of irrigation in the Nile Valley and to show how the labours of the civil engineer have created the highly complex irrigation system that exists there to-day, large-scale, illuminated maps were on view, supported by photographs, panoramas, working models, and a mechanised running commentary. Here it was the voice that slightly marred a very impressive display: the speaker had either been served with a hastily-prepared script or he had imperfectly rehearsed his lines, with the result that his facts and figures were unreliable. He was allowed to state, for instance, that the capacity of a reservoir was 5,000,000 tons, whereas that reservoir will hold 5,000,000,000 tons of water.

When the visitor had to depend upon the unaided eye, the professional exhibition designers still saw to it that their message was presented with full emphasis. A new technique of intermittent illumination had been worked out. Where this technique operated you were rarely allowed to see anything steadily or to see it whole; you were vouchsafed no more than a momentary glimpse of what you were trying to see, thereafter patiently waiting through the ensuing period of darkness until another brief spell of brightness enabled you to resume your study. There seemed to be no end to the various ways of making little electric lamps flash on and off. They did not always seem calculated to leave a clear, or at least a correct, impression on the mind of the beholder. At the Industrial Power exhibition an array of flickering lights purported to show the diffference between direct and alternating electric current. In fact, they were quite meaningless. At this same exhibition at Glasgow a design team had gone to a great deal of trouble to prepare a large illuminated diagram which aimed at explaining the working of a water-tube boiler. To an experienced observer it set interesting problems in trying to sort out the various circuits; to the uninstructed observer it probably conveyed the impression that the feed water was turned on and off every few seconds.

But while the wheel of fashion brought these new devices to the foreground, its remorseless rotation carried into view some charming old ones which we might have thought we had lost for ever. Waxworks—real Victorian waxworks, or possibly a synthetic substitute—have reappeared. On a full-scale reproduction of the poop of the "Endeavour" you may have seen full-scale three-dimensional effigies of Captain James Cook and his staff; in the "Hall of the Future" at Glasgow you may have peered down upon life-size figures of Rutherford, Parsons and their companions, each in the process of discovering truth at the bottom of his own particular well.

But is it really profitable to try to assess what effect any particular exhibit created upon the several thousand or several million visitors who saw it? The only single visitor whose impressions I am thoroughly competent to speak about is myself, and if these are recorded with a reasonable attempt at sincerity, it might be possible in the end to apply suitable processes of sedimentation, filtration and distillation and thereby to extract a few valid conclusions. If I say that I never succeeded in getting wholly into sympathy with the South Bank Exhibition, I think I can offer a plausible excuse. I could never find the equivalent of the bi-focal spectacles that would put me equally at ease with fact and with fancy. If the beautiful Medway sailing barge moored offshore carried such conviction to my mind, by what process of psychological gear changing could I prepare myself to receive the message of the more abstract exhibits on view? Why was it often so difficult to harmonise the ideals of the exhibition designer with those of the engineer designer? Of course, when the strain of trying to resolve these problems was lifted, I could enjoy the South Bank Exhibition just as well as anybody else; that would be on Waterloo bridge after nightfall, when the lights of London blazed and glittered as they had never done before.

Nobody going to the science exhibition at South Kensington had to ask what it was all about. There, facing all visitors as they entered, was a plain statement of what scientists had done during past centuries, with marks of commendation for outstanding achievements; you could dispute the order of priority, but you had to admit that the promoters had not shirked the task of assessment. They succeeded brilliantly, as I have said, in generating an air of excitement to the earlier stages of the visitor's pursuit of the mysteries of matter. Doubtless the excitement would flag later on; many visitors would lose touch and would be confronted with the incomprehensible; but at least there were no deliberate attempts to throw them off the scent by bits of fantasy interpolated in a close chain of logical reasoning. They had not to ask: "Am I supposed to understand this, or are the artist designers just having a bit of fun?-" Moreover, pleasantly near at hand, there was another exhibition which could be enjoyed without any reservation at all. It was the display of books in the Victoria and Albert Museum. I found this book exhibition wholly charming and delightful, and, for an Englishman only temporarily in his own country, strangely moving. It was not the place nor the time for criticism. Later on the thought did arise, might not technical books have been recognised? After all, technical titles do occupy a very large share of publishers' lists nowadays, and many readers prefer British technical works to any others.

My next visit was equally satisfying, although in a different way; I went to look at the display in the hall of the Royal Institute of British Architects in Portland Place

It is always a pleasure to enter this building at all, and now there was the added pleasure of studying this pictorial commentary on a century of British architecture. The photographs and perspective drawings were admirable and admirably arranged, with just the appropriate explanatory letterpress. Two examples of specifically engineering structures were illustrated: the Saltash bridge and the recent Twickenham bridge over the Thames. Later on I was to find that Brunel's bridge seemed to appeal rather specially to the Festival authorities, for in all the exhibitions I visited I noticed only two references to the Forth bridge and two to the Sydney Harbour bridge, whereas the Saltash bridge had three "mentions" or marks of distinction. Even if this was purely fortuitous, yet it would not be easy to challenge such a tribute to so great an engineer as the younger Brunel.

An expedition to the next item on the Festival programme—the "live" architecture display at Lansbury, Poplar—manifestly called for a mood of high adventure, for was there not a note of brave, even gay, defiance, about the whole project? In my role of foreign observer I certainly thought so. The British, so far from hiding their battle scars and the shady side of metropolitan splendour, were inviting me specially to see how they were trying to straighten things out. And evidently they meant business. Serving as a beacon to guide the visitor and as a symbol of the whole display, there was an immense jib crane set on a tall staging. The officials were eager to make us welcome, and as there were only a few dozen of us we could move about freely and see what we wanted. I remember especially a friendly guide at the nearly completed new Congregational church, an elderly resident, who was delighted to show us every detail of his buildings. Indeed, they had the engaging air of a glittering ingenious new toy. But how fragile they looked. Would this new church endure for a hundred years as its predecessor had done, I wondered? I had the same doubts at the new primary school on the Lansbury estate, one of those new structures that appear to consist of glass held together by faith. How hot it was inside, on this sweltering July afternoon. The samples of pupils' work displayed there were so varied and encouraging that one looked round for someone who could accept congratulations. Studying the drawings that ten-year-old boys had done, you could imagine that if they were to be enlarged to a linear scale of twenty to one, they would bear comparison with some of the murals at the South Bank Exhibition. Elsewhere at Lansbury one could make other comparisons with the South Bank. Some of the completed flats had been furnished and were open to inspection, so as to give an impression of what they might look like when tenanted. Although the accommodation did seem rather painfully restricted, yet the chairs were evidently designed for human beings to sit on comfortably, and the chests of drawers were meant to receive ordinary garments. The distorted, wild-eyed influence so manifest in some of the South Bank furniture had not yet penetrated as far as Poplar.

Besides contrasting one exhibition with another, we had the chance at Lansbury of comparing precept with performance. Here were models and charts to show how to avoid building defects; they explained that short piles in clay foundations would prevent cracking of the walls. Yet at Harlow New Town, only the day before, I had seen badly cracked walls in new industrial buildings that had only just been occupied. Nor did this surprise me, remembering how much more costly and more dilatory performance is than precept.

Always considerate, the Lansbury authorities had suggested that their guests should return to central London along the Thames itself. I found this plan most rewarding. On the motorbus to the West India Dock pier one could observe earlier attempts at improved housing on a large scale, and could reflect upon the tendency of exhibitions to assume that they were the first in the field in their own special sphere. On the waterbus, of course, I could only fully enjoy the scene by resuming the role of trueborn Englishman. And, as the tide and a touch of propeller bore us upstream, how rich the journey was, with interests ranging from Lady Jane Grey and Samuel Pepys to the Tower bridge and the half-finished Bankside power station.

That evening, my friends took me to the Pleasure Gardens at Battersea, still further upstream. Surely, I thought, here one would at last escape from that nagging doubt, was the purpose of the Festival to instruct or to amuse; no bi-focals would be needed here. Nor were they. One could wholly admire what the artist-designers could do when released from uncongenial association with the ungainly products of the engineer. A little bijou theatre they had contrived seemed particularly charming. Elsewhere, at Battersea, too, you felt free to find amusement as it came. Perhaps at the Emmett railway the fun was slightly o'ercast with thought: the joke had turned a little sour. Not only had there been a real accident on the line, but the platform at Far Tottering recalled uneasily the grass-grown, neglected, or totally-abandoned stations that real railway passengers observed nowadays. It was better to stand beside the big dipper, tracing the evolution of the switchback railway since one's childhood's days. Switchback, giant racer, big dipper—this favourite of the fairground had stood the test of time very sturdily. Moreover, as I found by experiment, the sensations it was designed to give to its patrons had remained unchanged throughout the years. To impart additional flavour to these reminiscences, one could move across to the flying cars, where, although the patrons were too young to know it, they were at last looping the loop. Or were they? Securely strapped into little cars running on rails within a vast rotating drum, they were whirled around in a vertical circular orbit. But whereas if you truly loop the loop you are upheld at the highest point of your travel by the force of radial acceleration, these venturesome but strangely silent passengers at Battersea could depend upon some mechanical system of flanges. In the days when the principal boy at a pantomime used to sing "Looping the Loop with Lucy, Lucy, . . .", the loop really was part of the track of a switchback railway: and that is why, when Monsieur Pégoud first looped the loop in an aeroplane in 1910, newspaper readers knew exactly what kind of feat he had performed. However, if any pleasure-seekers at Battersea were determined to see Newtonian forces spectacularly at work, they had only to watch the Hell Riders careering round the wall of death—a rather grisly sight. Every time the grim-faced motor-cyclist circled past, you could feel the structure lurch, and you glanced instinctively at the circumferential wire rope that tied the sections of the cylindrical wall together.

After these diversions it was undoubtedly time to get back to work again. In deciding how best to reach the Industrial Power exhibition at Glasgow, I was able to give my attendant foreign observer—my *alter ego*—the benefit of my own local knowledge. If we travelled north by the old Midland route, and returned by the East Coast route, we could have a private Festival of Britain display of our own. In the way of business, we should get a glimpse of the Forth Bridge, we should traverse the Royal Border bridge at Berwick and the King Edward VII high-level bridge at Newcastle, and we should thereby get good views of other modern structures—the great highway bridges over the Tweed and over the Tyne. In the way of pleasure, there would be the incomparable journey over the Settle and Carlisle line, and the memorable view of Durham Cathedral on the return trip. It all fell out exactly as I had hoped. Just the right kind of towering white clouds floated over Ingleborough and Penygent and the wild moorland landscape around them, the stimulating effect being so potent that it endured throughout my stay in Glasgow. After reaching St. Enoch's (dead on time too,—a courteous Festival gesture on the part of the engine crew) I went along to the Kelvin Hall as quickly as might be, and the following morning I was so willing to go again that I was on the doorstep on the stroke of ten.

Probably the enlivening influence of the exhibition was due in part to the diversity of treatment to be found in its various sections. As we learned from the guide-catalogue, each of these sections had been arranged by a different hand, and the resulting personal influence was clearly to be discerned. Immediately on entering, the visitor was faced with a momentous choice: he could take the way of light or what seemed to be the way of darkness. The right-hand path led him beneath cascades of water to the brilliantly-lit hall of Hydro-electric power: but if he turned to the left he would find himself in the subterranean gloom of a carboniferous swamp. But persistence in following either route would ultimately bring the traveller to pleasant regions—steel, civil engineering, railways or ships. It seemed to me that the character of the displays could be gauged by the style of the murals that embellished some of them. What was the message to be conveyed, for instance, by the immense wall-paintings in the hall of hydro-electricity or in the hall of power for industry? It was surely this, that as the artist had depicted what appeared to be the primeval chaos in which could be found the elements, material and spiritual, which might ultimately enter into the construction of a thermal or a hydro-electric power plant, the controlling mind was more concerned with mystical or symbolical relationships than with tangible shapes. In consequence, one detected in these parts of the exhibition a certain indifference to logical sequences and to factual statements.

Had I, indeed, been a foreign visitor, I should have been highly critical about the way in which information was presented. Having been induced by intensive publicity to travel many hundreds of miles in order to learn about hydro-electric developments in Scotland, why should I have found it so hard to find specific statements of these achievements? In such a mood I might have asked sardonically why there should be water spouting, foaming, and splashing, wasting energy in the most ostentatious manner, and indeed doing everything except what it ought to be doing, namely, flowing quietly through a turbine and there releasing its energy. As it was, I considered—in my capacity as a visitor who knew the country—that it was at least disingenuous to suggest that hydro-electric engineering in Scotland began in 1943, and that it was deliberately misleading to exclude from a map of Scotland all reference to the Galloway scheme. As

for the thermal-electric displays, the script-writers there were content to refer to "a current of 165,000 volts," "a current of 66,000 volts."

Because there were no such distractions in the hall of steel, I thought the exhibits here exceptionally happily chosen and well arranged. During the preceding sequence in the hall of coal, the visitor had seen an absorbing story unfolded with due dramatic emphasis; yet as the lighting had deliberately been kept at a low level, the warm glow in the hall of steel had itself a welcoming effect. Here you could learn not only about iron and steel, but about the men who had found out how to make steel; portraits, brief biographies, and pointed comments helped to explain the course of development in the industry. Studying this portrait gallery, and comparing the faces I knew with those that perhaps I ought to have known, I decided that Nasmyth was the most sympathetic figure and the man one would most willingly have met. In this hall of steel, too, were projected the only two "straight" cinema films in the exhibition. Both were excellent. The one sponsored by Babcock and Wilcox taught me a great deal about the working of chain-grate stokers; the Stewarts and Lloyds film showed very clearly the firm's new process for the continuous production of boiler tubes.

I remember seeing no portraits in the hall of civil engineering. It seemed rather odd, in a Scottish exhibition, to find no picture of Telford; indeed, his name only appeared at all when linked with a bridge he did not build—the projected great cast-iron arch across the Thames.

Another oddity was the anonymity of many of the photographs of civil engineering works. Although this may have been rather discouraging to the uninstructed visitor, it gave me the chance of a little amusement by awarding myself points for each picture I could identify. Scoring was easy at first; then the need of an umpire or referee became manifest. Here, for example, was an aerial view that almost certainly represented the King George V Graving Dock at Southampton, but was this the "Olympic" being warped into the dock, or was the ship still afloat at that time? To some of the other photographs I had to reply, like the victims of a Gallup poll, "Don't know."

Personalities came into their own again, although on a rather questionable scale of values, in the railways section of the exhibition. One could applaud the prominence awarded to Trevithick in the history of locomotive engineering, while wondering why Churchward engines were completely omitted from a pictorial survey of more recent developments. Here, in this section, it was some of the exhibits that suffered from anonymity. To symbolise the end of the story—the triumphant culmination of a century-and-a-half of evolution—a magnificent new locomotive was on view, the largest and possibly the most impressive single exhibit anywhere in the Kelvin Hall. But it was enshrouded in an air of aloof and mysterious majesty, for no word could be found to explain its duties.

And now, after a suitable lapse of time and due periods of rumination, can I make any kind of assessment that would justify so many hours of wandering round exhibitions and so many miles of travel? The first question is, did I enjoy myself? Surely the object of a Festival is to promote enjoyment? Of course I enjoyed it all immensely. All? Well, nearly all. For I can remind myself not only of dutiful treks through the corridors of the formal exhibitions but also of the bright new paint and the window boxes and the fluttering flags that made the streets of London so gay. Then, as an ordinary visitor, did I consider myself satisfied with what so numerous a host of people of all ranks had done for my edification? On the whole, yes. If I was at times disposed to rebel against the unseen hand, or the bodily presence of the uniformed attendants which in concert guided my steps along the narrow—but rarely rectilinear—path, possibly that can be laid to the account of my overseas experience which has largely shielded me from recent British regimentation. In principle, I had to agree that it was better to dispose the exhibits in corridors or their equivalent, where the visitors could be screened from distracting influences, and where the lighting could be appropriately regulated, rather than that the display should be massed in one huge, noisy hall. In regard to each exhibition as a whole, it seemed clear that success depended very much upon scale. The smaller the exhibition and the narrower its range, the more likely it was that uninterested and therefore potentially bored visitors would withdraw, leaving more room for the contented few. Doubtless, that is why the books exhibition at South Kensington left so pleasant an impression, why the Industrial Power exhibition at Glasgow seemed to be about the optimum size, and why the vast extent and variety of the material at the South Bank induced the fatigue and bewilderment that were apt to afflict the frailer sightseers.

A more vigorous effort of the imagination was required to form any conception of what an achievement the Festival displays really represented. I had seen only a few of them, but I knew how many others there were. I had read technical accounts of the great engineering works at the South Bank—the new embankment, the shell of the Royal Festival Hall, the roof of the Dome of Discovery—and now I had to imagine the task of collecting the major exhibits and of physically moving them into position. It was just here that any overseas observer is at a disadvantage—he is hardly likely to have had harsh personal experience of the difficulties, delays and frustrations that attend all constructional tasks in Great Britain. On the personal side, how had it been possible to engage so great a company of engineers, architects, designers, artists; to quicken their inventive talents; to harmonise their efforts; and to deploy the executive ability that should complete this immense work of creation within the space of three years? Such thoughts should give pride and satisfaction to any Briton.

The one particular question, though, that obtruded itself upon the technical observer at nearly every step was this: what is, and what should be, the relationship between the engineer-designer and the artist-designer or, if you like, between the engineer and the artist in the widest meaning of the term? When the artist was allotted the task of telling the story of the engineer's achievements during the past two centuries, did he carry out the task to the engineer's satisfaction or not? Was this co-operation successful enough to justify the engineer in continuing to rely upon the artist as his public relations officer in future? Has the artist displayed gifts of exposition that suggest he can expound the engineer's work better than the engineer himself can? On the other hand, has this enforced association given the engineer a broader conception of his own activities? May he profit from the more imaginative and possibly mystical interpretation that the artist has vouchsafed?

These are not trivial questions. More and more the technician will need allies who can interpret his work truthfully to the public. The engineer can no longer afford to let his works speak for themselves, especially when their impact upon ordinary men is experienced in terms of power cuts, unsightly cooling towers, and unkempt, sluggardly trains. In his unending task of training new engineers who will carry on his own work, faced with a steadily widening range of techniques that must be made known to his pupils, the engineer himself cannot afford to neglect any source of illumination. Nor, of course, are these new questions that have been posed. In one sense it might be said that the collaboration between the engineer and the artist in his function of architect goes back to Stonehenge or to the Temple of Karnak. If the artist as writer has not directly helped, that is only because the writer's influence is so widely diffused that the engineer instinctively benefits from it. The distinctively new personality in the team is the professional exhibition designer or artist, no matter in which of his numerous guises he presents himself. He is the man whose influence we should more particularly scrutinise. Without any special claims to comment on his notable successes in stimulating, inspiring, suggesting, decorating, diverting, or amusing, yet we do remember that he undertook to tell a story, and one part of the story concerned the achievements of the engineer.

Unfortunately from our point of view, the storyteller will not be content to tell a straight tale, and his embellishments are often more likely to confuse than to illuminate. One might almost imagine that he sometimes regards factual statement as not merely undesirable, but actually vicious; or, of course, it may be that he considers that if you already know what the exhibit is, you will not want an explanation, and if you do not know, you would not understand an explanation. So why give it? As for soundness of judgment, it can be gauged by such a comment he offers as this: "The British are the greatest irrigators in history." Frequently, too, one was conscious that the storyteller was much more interested in the pattern of his own creation than in the material from which he would build his pattern. If he thought a chessboard pattern would look nice, he might not worry unduly about what kind of pictures filled in the squares; even if they were upside down it might not matter very much. Then there was a tendency to treat valuable engineers' drawings as though they were so much wallpaper, to leave intractable objects such as marine screw propellers just lying around if they ceased to interest the storyteller, and when weariness finally supervened, to relapse into sheer childishness. Playing with words is one thing and playing with things is another, but when these pastimes are combined in a serious exhibition, a gentle protest might be justified. At Glasgow a trifling toy was gravely labelled "The Theory of Structures, a Fantasy Illustrating in Symbolic Form the Main Problems of Metal Construction." It did nothing of the sort.

In his capacity as expositor the storyteller was still hampered by the same failing—his inability to keep in their proper place such gay decorative devices as fantasy, whimsicality, freakishness, or perhaps even perversity. As a result of this output of misdirected ingenuity much of the explanatory material offered was too clever by half: the illustrative comment was of the type that every educationist knows, that remains in the mind of the student while the basic principle involved is wholly forgotten.

There is no question here of dull-witted engineers who cannot relax, who cannot see a joke. We merely want to find out how best to get on terms with our new collaborators who have so often succeeded brilliantly in what they have undertaken, but who do not always understand our own idiom. The more quickly we reach agreement, the more fruitful our future operations in common are likely to be.

The S.B.A.C. Flying Display and Exhibition

No. IV—(*Continued from page 394, September 28th*)

Helicopters

The status of helicopter development in this country and the immediate future prospects of its use for air transport has been thoroughly examined by the Interdepartmental Helicopter Committee appointed by the Ministry of Civil Aviation. Its report, issued this year, indicated that the limited commercial use of a 10/12-seat twin-engined machine was possible by 1954 for distances up to 300 miles, though not fully economical. It stated, however, that the manufacture of transport helicopters in this country was still at an early stage and that much development work had still to be done. Machines already flying were single engined and too small for public transport vehicles. It was one conclusion of the committee that all commercial helicopters should be multi-engined machines. A fully economic commercial machine would need to carry a minimum of twenty passengers to be economical on distances up to 300 miles, but to anticipate a capacity significantly greater would not be justified on technical grounds within the next few years. The report states that the present 10/12-passenger machines being developed represent an indispensable transitionary stage in the development of a fully commercial machine.

There are four main companies in this country engaged upon helicopter construction. The Westland Aircraft, Ltd., are producing under licence from Sikorsky a single-engined, single-rotor machine, the Westland-Sikorsky "S 51," which is illustrated below. Obviously the most desirable characteristic of a helicopter is its ability, with normal loads, to descend at controlled rates vertically or to hover. It derives in general from these characteristics the advantage of point-to-point locomotion with vertical ascent and descent, if necessary, upon City roof-top areas which could readily be made available. The applications for which the Westland "S 51" has been employed are almost too numerous to mention. The general proportions of the aircraft can be seen from our illustration. It is designed to carry three passengers and a pilot. The main rotor is 48ft diameter and the vertical tail rotor 8ft 5in, both rotors being driven by an Alvis "Leonides" radial engine of 500 h.p. With a cruising speed of 85 m.p.h. and a pay load of 530 lb, the gross weight being 5700 lb, the fuel consumption is 23 gallons per hour. Apart from its many well-known military uses, the helicopter is particularly suited for certain crop spraying and dusting purposes in distinction to other methods of aerial spraying techniques. Due to the downwash created by the rotors and the very slow forward speed, the crop leaves are agitated and the chemical more effectively infiltrates amongst the growth. Flying only a few feet above the ground there is consequently less risk of damage to adjacent crops, and little risk of the aircraft colliding with ground objects.

The other helicopter demonstrated was the "Sycamore type 171," Mark 3, made by the Bristol Aeroplane Company, Ltd. This particular prototype, which was designed under Ministry of Supply contract, is expected to be the production version.

First flown in July, 1947, the "171" has since completed many hundred of hours' flight testing, and is now undergoing tropical and arctic trials. As a four-five-seater of orthodox lay-out, it is intended for air taxi or feeder-line services or for military use on observation, reconnaissance and air/sea or mountain rescue. For casualty evacuation duties, two Perspex blisters can be fitted behind the pilot's station to enable two stretchers to be carried athwart the fuselage. The type "171" is powered by a 550 h.p. Alvis "Leonides" radial engine, and has a main rotor diameter of 48ft 6·7in, overall length (blades folded) 43ft 8·5in, and height (to top of tail rotor disc) 13ft 10in

THE BRISTOL "TYPE 171" MK. III (SYCAMORE) HELICOPTER

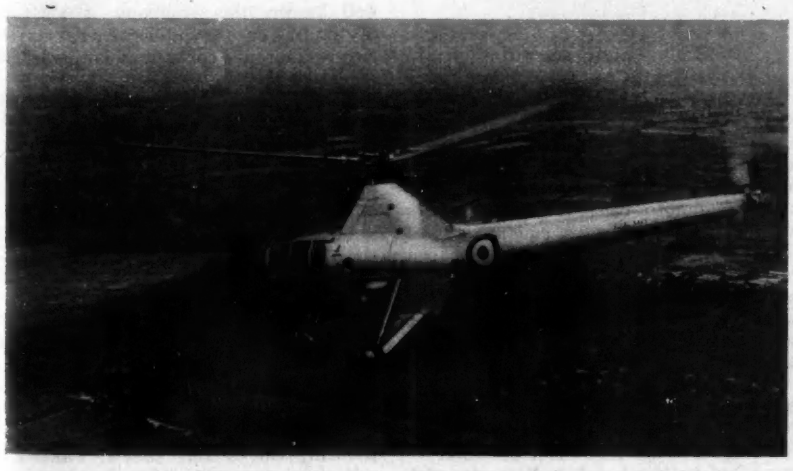
The all-up weight is 5200 lb and it has a maximum level speed of 141 m.p.h., and a cruising speed of 105 m.p.h.

This aircraft is distinctly manœuvrable. It demonstrated steeply banked turns close to the enclosure, span about its own rotor, and at other times climbed away backwards.

One of the intermediate machines of which the report made mention is the Bristol type "173," which is now under construction.

The type "173" is intended primarily as a medium or short-range transport for 10–13 passengers, or 2500 lb of freight, and it has a normal all-up weight of 10,600 lb. The two Alvis "Leonides LE.23 H.M." radial engines, of 550 h.p. each, are situated approximately beneath the two rotors. A synchronising shaft ensures that both turn at the same speed and permits one engine to drive both rotors if the other should fail. Rotor blades and hubs and many other components are identical to those already proven in the type "171." The diameter of each rotor is 48ft 6·7in, and the main dimensions with blades folded are: length, 78ft 2in, width 17ft, and height 15ft. The estimated maximum level speed is 142 m.p.h.

Another and larger helicopter which did not appear at the display is the "W 11 Air Horse," development of which has been taken over from the Cierva Autogiro Company by Saunders Roe. The second prototype has now been fully examined following a fatigue failure in a component which caused the loss in the air of the original machine.



WESTLAND-SIKORSKY "S 51" HELICOPTER

This aircraft has a Rolls-Royce "Merlin 24" engine, which drives a configuration of three rotors and the machine is capable of carrying twenty-four passengers.

The Cierva Company had also a design contract for a 24/32-passenger helicopter, the "W 11 T," which was to have twin "Merlin 500" engines, each developing 1285 h.p. and also driving three rotors. Its designed maximum speed was 140 m.p.h. Development of the very small "Skeeter" helicopters has also been taken over by Saunders Roe.

The Fairey Aviation Company, Ltd., is also engaged in helicopter development, and in December, 1947, it had flown the "Gyrodyne," a private venture machine of unorthodox design, and now abandoned. This firm is now engaged upon a new project, the Fairey "Rotodyne." It is stated to be fitted with two gas turbines and to use jet-reaction units at the rotor wing tips, to which compressed air is ducted. It is designed to cruise at 135 m.p.h. with twenty-three passengers.

The Static Exhibition

There were nearly 200 separate display stands in this year's indoor exhibition. Manufacturers of aircraft and engines were again displaying models and many of Britain's gas turbines were shown in sectioned form, which in some cases were actuated. Space does not permit a further description of these established units, but D. Napier and Son, Ltd., was showing its compounded engine, the "Nomad."

The "Nomad" engine was designed as a compounded unit and it will be the first engine of this kind to make a public appearance. It is a highly supercharged two-stroke compression ignition engine, associated with an exhaust-driven gas turbine.

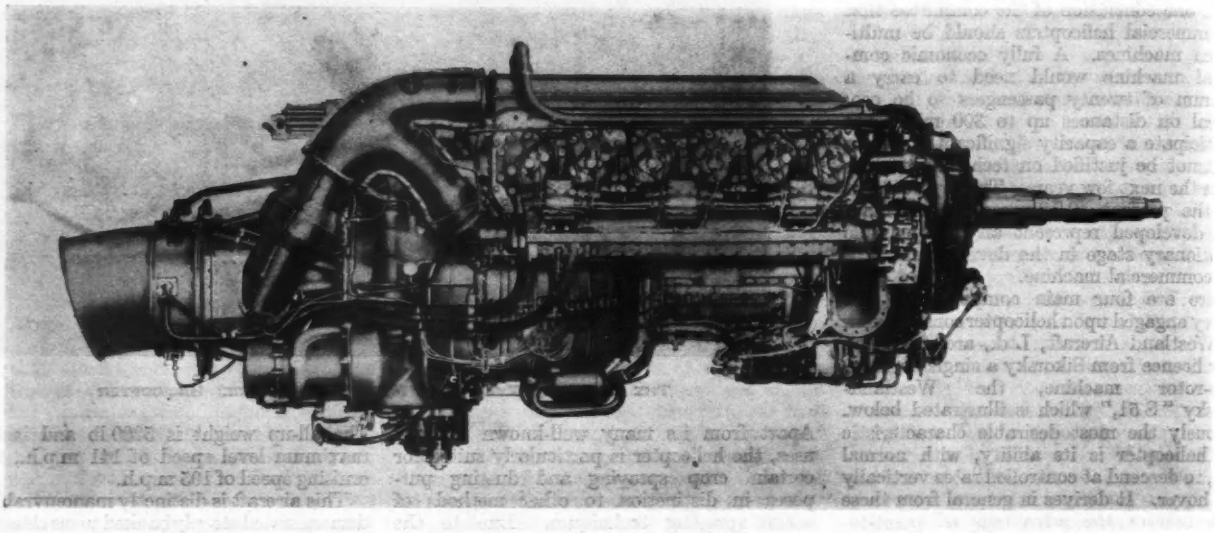
Such a combination of reciprocating and rotating power units has characteristically high thermal efficiencies with correspondingly low fuel consumptions. The primary purpose of the "Nomad" is, therefore, to allow economical air transport over long distances.

As exhibited at Farnborough, the engine comprises a twelve-cylinder horizontally-opposed compression ignition engine, which delivers power into one half of a counter-rotating propeller, the engine being supercharged by an axial compressor and a centrifugal compressor in series. Exhaust gas from the engine is fed into a gas turbine, which drives the other propeller. Two auxiliary combustion chambers are fitted, in which additional fuel may be burned to provide maximum power for take-off, an auxiliary turbine being used under these conditions.

It develops at take-off (sea level static) 3000 s.h.p and 320 lb thrust. The fuel consumption (kerosene or diesel) under these conditions but operating at maximum continuous power, is 0·360 lb per effective horsepower per hour. Comparative fuel consumptions of typical reciprocating engines under these static conditions are not readily available but some approximate fuel consumptions (petrol) at maximum continuous power at various altitudes are as follows :—

The Alvis "Leonides 502/4," 410 b.h.p. at 9750ft, consumption about 0·66 lb/b.h.p./hour ; the "Griffon 57," 1360 h.p. at 6000ft, consumption about 0·7 lb/b.h.p./hour ; the "Centaurus 661," 1755 b.h.p. at 13,000ft, consumption about 0·5 lb/b.h.p./hour ; the "Gypsy Major 10/2," 142 h.p. at sea level, consumption 0·62 lb/b.h.p./hour. The net dry weight of the "Nomad" is 4200 lb, its length 126½in, width 58½in and depth 49½in.

The engine exhibits of the Hawker Siddeley group included the new "Snarler ASSn1" bi-fuel rocket motor. Its liqud propellants enable a 2000 lb thrust to be developed.



NAPIER "NOMAD" COMPOSITE ENGINE

Hydraulic Equipment

An important safety contribution to hydraulic systems is a new pressure relay produced by the Dunlop Rubber Company. It was described in our issue last week.

Another of this company's valves has been designed essentially for fuel tank pressurisation. Its output pressure is maintained throughout a range of input pressures between 5 lb and 200 lb per square inch, if taken from the jet engine blower. If a nitrogen container is used the valve is suitable for an input pressure of 3500 lb per square inch. The main purpose of the valve, apart from transferring fuel from tank to engine, is to prevent collapse of the tank during a protracted high-speed diving operation. In these circumstances the valve will deliver 70 cubic feet of free air per minute to the interior of the tank.

Other valves displayed had to do with differential and foot-linkage hydraulic brake controls and the "Maxovet" automatic brake control was shown.

Amongst other equipment displayed by the Dunlop Rubber Company were examples of its plate brake installations. The kinetic energy capacity of a recent design is stated to be $21 \cdot 9 \times 10^6$ft-lb. for a wheel weighing 110 lb, the brake 127 lb and the brake plates 33 lb.

A variable delivery hydraulic aircraft pump, which has recently passed British type approval tests, was shown on the stand of Dowty Equipment, Ltd. The unit employs a first-stage gear pump and a second-stage radial piston pump.

This pump has been designed for general use in aircraft hydraulic circuits. No external control gear is required ; the pump provides a complete hydraulic power system which accommodates itself to the demands of the hydraulic services. Off-load (zero delivery) pressures from 2000 lb to 4000 lb per square inch are available, the nominal rate of delivery, 5 imperial gallons per minute at 3000 r.p.m., being maintained up to 90 per cent of the off-load pressure at all settings. Above 90 per cent of the off-load pressure the delivery decreases until at the off-load pressure the delivery is zero.

The control gear fitted to this pump virtually eliminates the "flick" or transient shock pressure generated when the pump has instantaneously to cease delivery on completion of a service selection. As is well known, this company is also maker of liquid sprung undercarriage systems, electro-hydraulic controls and other hydraulic actuators.

On the stand of Electro-Hydraulics, Ltd., Warrington, were exhibited a selection of hydraulic and electro-hydraulic valves and of jacks suitable for pneumatic or hydraulic operation. A working demonstration showed a jack with its internal lock system.

The Hymatic Engineering Company, Ltd., was showing a number of recently developed or improved components. Its recently adopted compressor, type "S50U," now flying on the "Balliol" aircraft, was shown, which has a performance giving twice the working life of its predecessor, with a 35 per cent greater delivery of air at 1000 lb per square inch. It weighs only 6 lb. For bleeding from gas turbine compressors two reducing valves were shown, which have a capacity up to 35 cubic feet per minute.

The smallest of these is used in some aircraft for the pressurisation of fuel tanks. Other reduction valves shown had output pressures down from 20 lb to 2·5 lb per square inch and a series of non-return valves with a maximum back pressure of 0·5 lb per square inch, the smallest weighing 1·12 oz. Also exhibited was the latest "Hymatic Anti-G" valve, used to counteract the effects of centrifugal loading on pilots.

A range of motorised spherical plug cocks was displayed by Saunders Valve Company, Ltd., which can be used in systems handling most liquid or gaseous fluids associated with aircraft operation. The 1in hot-air cock has a rotary actuator, working at 20 r.p.m. The weight of the 2in motorised cock is 3·82 lb.

A particularly complete range of components for electro-pneumatic/hydraulic fuel and hot-air systems was displayed by Teddington Controls, Ltd. Amongst these were thermostatic inching controls and a range of seamless bellows, made from different metals and alloys. In the design of its hot-air valves, valve movement is kept proportional to the actuator movement by the use of a slatted carbon gate in many units, whilst others employ a stainless steel gate plate. Some of these units have multiple ports with sequential opening.

The Tiltman Langley Laboratories, which is a research and development company, was showing two of its developments. One is a servo-operated flow valve controlling flows at high pressures with very small powers, both with "on-off" control and with metered control. The valve is adaptable to aircraft fuel and oil systems and to pressure refuelling problems.

Its second exhibit was the Gerritsen variable speed gear, which demonstrated for the first time a small fractional horse-power reduction gear dealing with ratios from 500 to 50 : 1 reduction with torques to a maximum of 4 to 5 lb-inches. This gear has been developed to meet demands for small actuator control, instrument operation and counters. Details are also obtainable of drives where constant output speed is required for varying input speed.

Air Conditioning Equipment

Amongst firms displaying cabin superchargers, cold air units and equipment associated with air-conditioning modern aircraft, was Sir George Godfrey and Partners, Ltd., Hanworth, Middlesex. Its type "15" cabin supercharger, fitted with manifold and adaptor gearbox, is fitted in the B.O.A.C. "Argonaut" aircraft and it maintains a cabin altitude of 8000ft when flying at 20,000ft. The blower employs the Roots principle.

It now provides air in excess of 20 lb per minute at rated altitudes and operational speeds up to 11,500 r.p.m. The supercharger is also in production for the Vickers "Viscount" and the Airspeed "Ambassador." A new supercharger, with two stages, is also being developed for very high altitude aircraft.

This company's cold air units, which work on the air cycle are in production for the "Comet," "Viscount" and "Ambassador" aircraft and certain military machines.

Cabin atmosphere control equipment enables modern aircraft to be operated at extreme altitudes and under all climatic conditions in complete safety and comfort. The equipment made by Normalair, Ltd., Yeovil, controls cabin pressure and the rates of change of pressure to acceptable figures and, at the same time, ensures that the amount of air supplied, its distribution, temperature and humidity are regulated to provide the best possible internal conditions.

The main exhibit of this company was an animated diagram of the particular installation fitted in the de Havilland "Comet."

Joseph Lucas (Gas Turbine Equipment), Ltd., was showing several items from its range of fuel pumps, control units and burners. This company has developed the "D" Mk. II fuel pump, to satisfy the enormous rates of fuel consumption experienced with after-burning equipment. It has an available flow of 1400 g.p.h. at a pressure of 2000 lb per square inch at 3000 r.p.m., and there is to be an even larger version, mounting two of these pumps integrally and served by a common centrifugal governor. Development is also proceeding on a new governor which operates at set values, irrespective of variations in density over the range of fuels used at the increased speeds and altitudes encountered.

It is not possible on this occasion to describe these units or the company's latest control units for predetermining fuel/air ratios.

Amongst many interesting items on the Ministry of Supply stand was a plastic delta wing, which is to be used on an undisclosed aircraft. This display included a bi-fuel supersonic research rocket, 24ft long; a range of telemetering transducers and a transonic drag model, which is fired upwards and its "free" fall observed by optical devices.

Power operated controls were featured on several stands and the "Servodyne" system was demonstrated on the stand of Automotive Products Company, Ltd. Boulton Paul was also demonstrating one of its high fidelity power control systems, along with a twenty-four point pressure plotting recorder, a six-channel flight recorder for measuring strains, &c., and an automatic manometer, which consists of two electronic self-balancing instruments and was designed basically by the R.A.E.

The Paris Machine Tool Exhibition

No. III—(*Continued from page 392, September 28th*)

THE automatics exhibited by Tavannes Machines Company, S.A., of Tavannes, Switzerland, included the single-spindle automatic we illustrate in Fig. 14, and a six-spindle vertical "Gyromatic."

The single-spindle machine is normally built for bar work, 1⅛in. diameter up to 7½in long, but can be supplied with headstocks for ⅝in, 1in and 2⅜in work. This machine has a travelling headstock which moves along large vee ways and feeds the stock through a rotating guide bush. Feeding of the bar through the collet takes place as the headstock withdraws and clamping is effected through chains at any position of the headstock.

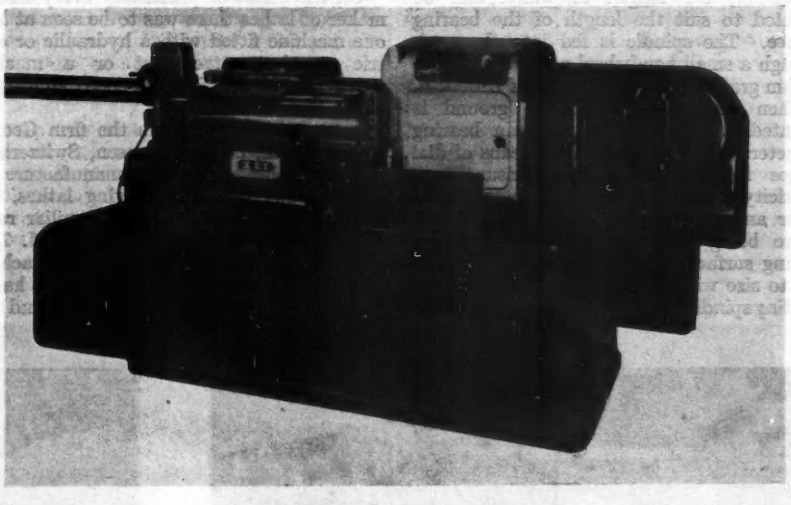


Fig. 14—Single Spindle Automatic

As the bar is fed through the guide bush of the machine it passes between two heavily built vertical cross slides, on each of which up to three tools can be set. The tools, which are brought into working position by rapid vertical movements of the slides as the bar is fed forwards, have a stroke of 1$\frac{3}{16}$in. The cross slide with two tools fitted can be seen in the photograph reproduced in Fig. 15. A six-spindle turret on the machine is normally fitted with non-rotating spindles, but for such work as high-speed drilling, thread cutting, &c., rotating spindles can be fitted.

The machine is operated through only four cams for the headstock, two cross slides and the turret spindles. Fifty-one work spindle speeds from 90 to 2308 r.p.m. are available on the 1⅛in machine with higher and lower ranges for the other types. Each machine has fifty-one feed rates to give production rates from 8 to 206 components an hour. Three different turret spindle speeds are available for the operations on a single component and a recessing spindle enables internal recesses to be cut at any of the six positions of the turret. A copying device available with the machine can be used with components up to 21in long.

The "Gyromatic" shown by the firm was the intermediate of three sizes of this machine, which is made for bars up to 1in, 1⅛in and 2⅜in, or chucking work up to 4in, 5½in and 7½in diameter.

This machine has six working stations,

each of which is fitted with a cross slide or a longitudinal slide, which swivels on three of the six stations. A rotating or non-rotating bottom tool barrel is set at each station and the slides and barrels are independent. The vertical arrangement of the machine reduces considerably the area of floor space required, and the makers state that wear on the rotating parts is greatly reduced, whilst setting is quick and easy.

The machine exhibited was driven by a 13·5 h.p. motor and it has thirty-one spindle speeds from 61 to 1560 r.p.m. with twenty-five feed rates. It can be fitted with special longitudinal slides for cylindrical turning and inclinable or universal slides for taper turning, &c., as well as copying apparatus. Other equipment supplied on special request includes rotating tool spindles, a tapping and thread cutting attachment, special tool holders, &c.

Tavannes equipment is handled in this country by Stanley Howard, Ltd., of 75–76, Exchange Buildings, Stephenson Place, Birmingham, 5.

A crankshaft grinding machine built on unusual lines and designed for simplicity in setting and operation was demonstrated on the stand of Les Ateliers de Construction J. De Buyser, of 118, Rue des Coteaux, Brussels, Belgium. This machine consists of a heavy base, in which a horizontal rotating table carries a substantial slide movable between graduated ways. A rigid box section column cast integral with the base is set at the side of the table and carries on large ways a grinding head. Mounted at the upper end of the column ways is a sliding bracket. Crankshafts to be ground are mounted vertically in the machine between the table and a centre or chuck in the bracket at the upper end of the column.

The grinding head is movable over a length of 50in. on the column ways through a handwheel. Its projecting horizontal spindle, which is fitted with a special cone-shaped wheel, has a vertical oscillating movement, the length of which can be adjusted to suit the length of the bearing surface. The spindle is fed into the work through a small handwheel with reference to a drum graduated in increments of 0·0004in.

When the crankshaft to be ground is mounted in the machine its main bearing diameters are first checked by means of dial gauges from the column to ensure concentricity and true running between the upper and lower ends, the table slide and centre being adjusted accordingly. These bearing surfaces are then ground concentric and to size with the table rotating, and the grinding spindle fed in to the same distance on each bearing. Then by operating the table slide and moving top centre support the shaft is moved over to bring the next throw bearing surfaces concentric with the axis of rotation. When this operation is completed and the setting checked with the use of gauges the table is started and the next grinding operation completed.

This machine takes crankshafts up to 60in long with a throw of up to 4in, the table slide having a travel of 7½in and the grinding wheel spindle a travel of 3in.

On the stand of practically every leading maker of lathes there was to be seen at least one machine fitted with a hydraulic or electric copying attachment or a machine specially designed for high-speed copy turning.

For a number of years the firm Georges Fischer, Ltd., of Schaffhausen, Switzerland, has specialised in the manufacture of hydraulically operated copying lathes, and it exhibited in addition to its familiar range of machines a new lathe, the KDM. 7/50, illustrated in Fig. 16. Unlike other machines made by the company, the new lathe has its saddle mounted above the work and not below, with the single point tool working downwards. The hydraulic copying slide on which the tool is carried can be set either in the vertical position in respect to the work or tilted up to 30 deg. on either side when it is required to copy turn steep shoulders or tapers facing the right or left-hand ends of the workpiece. Turning in progress with the slide inclined at an angle can be seen in Fig. 17. It will be appreciated from this illustration that with the new saddle arrangement clearance of swarf is facilitated and work loading and unloading can be effected more quickly and easily.

The master workpiece it is required to reproduce or a template is mounted above the saddle as shown. Work up to 5¼in diameter can be turned either with the slide vertical or at an angle. The maximum turning length is 20in. with the slide tilted and 26in when it is set vertically. The tool slide has a travel of 2¾in under hydraulic control and means of hand adjustment up to ¼in is available for setting.

A standard range of eight spindle speeds from 180 to 2000 r.p.m. can be increased to 2800 for intermittent use in special work.

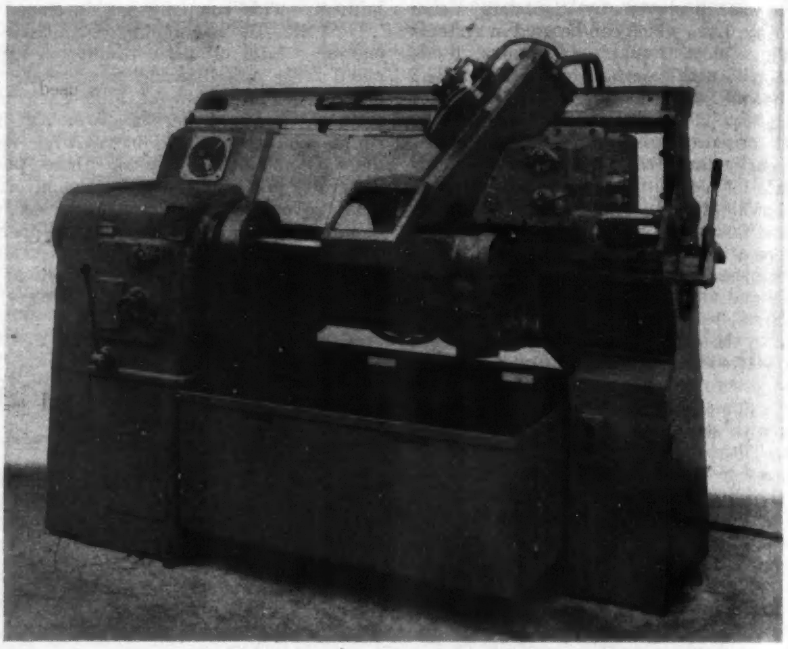


FIG. 16—HYDRAULIC COPYING LATHE

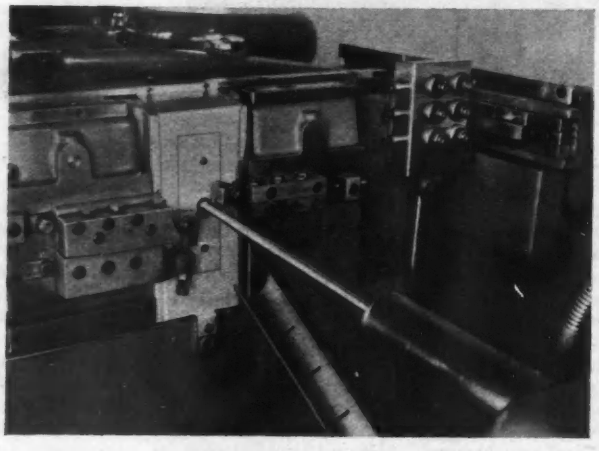


FIG. 15—CROSS SLIDES OF SINGLE SPINDLE AUTOMATIC

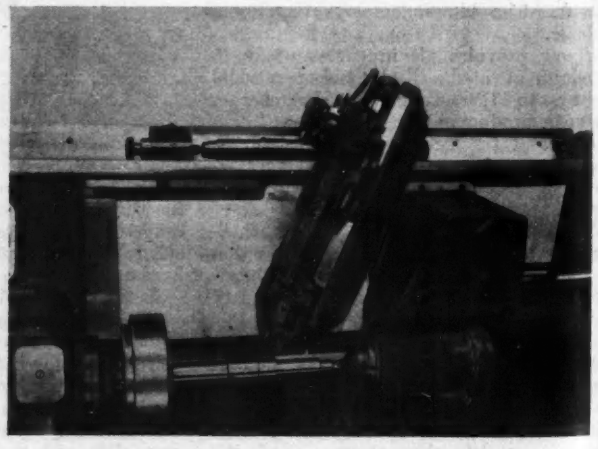


FIG. 17—COPYING SLIDE IN TILTED POSITION

An infinitely variable range of saddle feeds from 0·0028in to 0·028in per revolution of the spindle is available and feeds can be automatically reduced by half whilst cutting is in progress. By means of an automatic skip feed portions of work which do not require machining can be bridged over. By the use of a hydraulically operated infeed attachment a multi-cut recycling device, giving up to six cuts, and other attachments

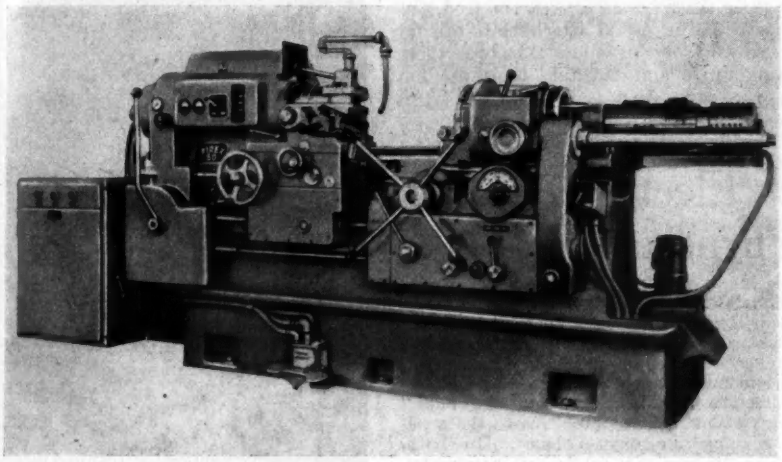


FIG. 18—"PIREX 50" TURRET LATHE

the machine can be largely adapted for automatic operation.

Georges Fischer, Ltd., is represented in this country by Sidney G. Jones, Ltd., of 8, Balham Hill, London, S.W.12.

One of the very few British machine tool making firms represented at the exhibition was the Keighley Grinders (Machine Tools), Ltd., of Newall Group Sales, Ltd., Peterborough. This firm showed three models of its well-known range of precision universal grinders. One of these machines was fitted with the maker's design of electrically operated work sizers and another with the new design of workhead, shown in Fig. 20. This workhead is driven by an electric motor through a two-speed gear and a Kopp infinitely variable speed gear unit. By this arrangement there are therefore two ranges of infinitely variable speeds available. Both the spindle and the workhead on one of the machines exhibited were fitted with the firm's latest type of self-adjusting bearings, which automatically compensate for wear.

Another lathe designed for high-speed precision production which was fitted with a hydraulic copying attachment was shown on the stand of Le Progrès Industriel S.A., of Lot, Brussels, a company represented in Great Britain by Soag Machine Tools, Ltd. This machine also had a electro-hydraulically operated attachment for feeding bar stock through the headstock spindle, and a hydraulically operated bar chuck. This bar feed attachment can be seen in Fig. 19, and at the rear, above the lathe bed, is the template holder for the copying slide. In the copy slide at the rear of the cross slide provision is made for both transverse and longitudinal copy turning.

The machine has centres 210mm high and takes work up to 1000mm long and swings up to 245mm diameter over the saddle. It is powered by a 20 h.p. motor, giving eighteen spindle speeds from 28 to 2800 r.p.m. with eight feed rates.

On a copying lathe shown by Gebr. Heinemann A.G., St. Georgen, Schartzwald, Germany, the copying attachment was arranged as a unit which could be removed for the machine to be used as a normal multi-tool lathe. When the machine is used for copying work with vertical shoulders one or more tools mounted on the rear of the cross slide can be fed in at the end of the copying operation to form shoulders or undercuts on the right or left-hand sides of the profiles cut on the work.

A lathe fitted with an electrically operated copying attachment demonstrated on the stand of Heid Maschinenfabrik, Mahlerstr 6, Vienna, Austria, had a number of interesting points. This machine, which is made in two sizes each to swing work up to 480mm diameter and in lengths of 1000mm and 1500mm, has its tailstock mounted on separate vertical ways at the rear of the main bed. With this arrangement not only is the saddle free to traverse the whole length of the bed and beyond the tailstock, but steadies can be fitted on the vertical tailstock ways to support long work without obstructing the saddle movement.

The saddle and cross slide feeds are actuated through electro-magnetic clutches, which work in conjunction with micrometer stops. For copy turning the master piece or template is mounted on brackets over the top of the vertical tailstock slide and during machining movements of a stylus over the profile actuates the electro-magnetic clutches of the two tool slide feeds.

A number of improvements have been introduced with a view to increasing production speeds on the new "Pirex" turret lathes made by Nassovia-Pittler-Dienst G.m.b.H. of Langen, Germany, a firm which is now represented in this country by Drummond-Asquith (Sales), Ltd. This machine is at present being built in two models, the largest of which, the "Pirex 50," is illustrated in Fig. 18.

As in other types of Pittler turret lathes, the turret head carries a large horizontal shaft which lies parallel to the axis of the bed and on which is mounted a round indexing turret tool plate. This plate is bored to take up to sixteen tools and, if required, up to three tools can be arranged to work in conjunction at one indexing station of the head. With such multi-tooling it is possible, for example, to drill a component whilst at the same time two turning operations are performed.

The spindle is bored to take bar stock up to 2in diameter and when the machine is used for chucking, work up to 9·8in diameter can be swung over the saddle and 15·7in diameter over the bed. The distance between the spindle nose and the turret face is 25½in. Eleven spindle speeds from 18 to 1800 r.p.m. are available in each direction with a range of turret sliding feeds from 0·001in to 0·040in. per revolution.

Spindle speeds are selected instantaneously through the operation of electro-magnetic clutches on the gear shafts in the geared headstock of the machine and with reference to a large indicator plate on the saddle.

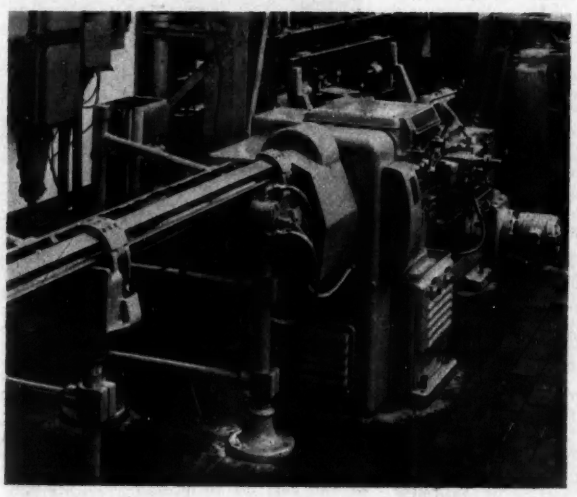


FIG. 19—COPYING LATHE WITH BAR FEED

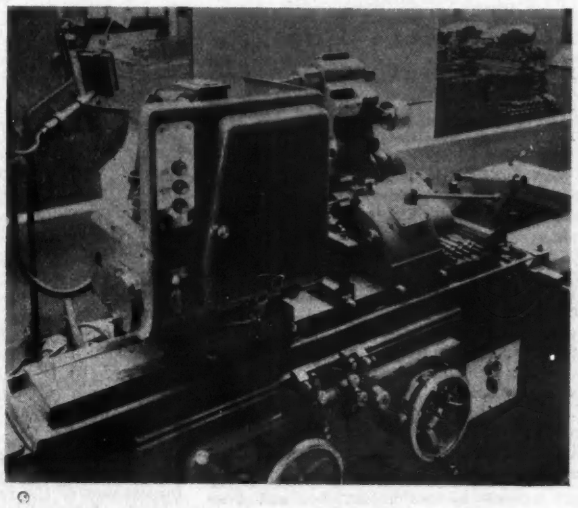


FIG. 20—WORKHEAD ON UNIVERSAL GRINDER

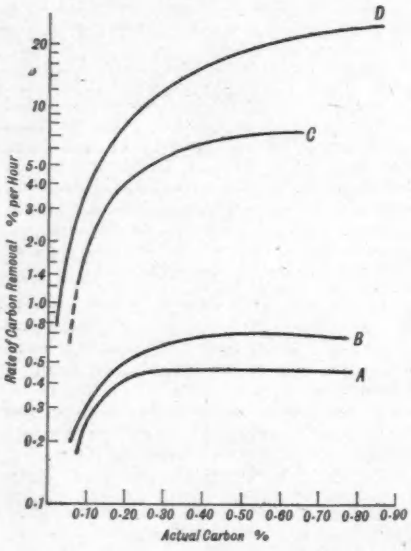
When components are being produced in large numbers the spindle speeds can be preset so that they are changed on turret indexing in accordance with the tool rotation. For this automatic spindle speed selection pegs are arranged in a drum at the rear of the turret shaft and, on indexing, those pegs actuate the appropriate clutches in the headstock.

A cross slide with a longitudinal working stroke of 12·2in has feeds from 0·001in to 0·04in per spindle revolution and can be set to work simultaneously with turret head movement. It is fitted with a four-way tool post and over its facing stroke of 5·9in has automatic feeds ranging from 0·0005in to 0·02in per revolution. In order that the tools in the turret head will not interfere with the operation of tools on the cross slide, work in the main spindle is aligned with the tool hole in the turret plate, which is at 45 deg. in front of the machine axis.

A chasing attachment for cutting inside and outside threads is fitted. In this unit an interchangeable leader driven from the headstock spindle by spur gearing engages a corresponding follower, which imparts the required pitch feed. At the end of each cut an adjustable stop on the bed automatically disengages the follower to stop the feed. A wide selection of useful attachments can be supplied with these machines to increase their working range and facilitate their use for high-speed production.

Oxygen Lancing in Electric Arc Steelmaking Furnaces*

BY lancing oxygen into the bath of molten metal in an electric arc steelmaking furnace the steelmaker can save time and increase steel output by speeding up the removal of carbon from the metal (see Fig. 1). He can, by careful management, bring the carbon to lower limits than are otherwise possible and can produce a cleaner steel, while conserving valuable alloys. During the last three or four years this technique has become routine production practice in many works in the United Kingdom, and more detailed knowledge and experience have become available since it was described in this journal some fifteen months ago (June 16, 1950). At a recent conference of steelmakers, organised by the British Iron and Steel Research Association, at Leamington, on September 19th and 20th, the position was reviewed in this light and the operational details at several works were discussed. Mr. R. W. Evans (Steel Company of Wales) was Chairman of the Conference, and Mr. J. R. Rait (Hadfields Ltd.,) acted as Vice-chairman during the sessions concerned with oxygen lancing. The conference also discussed the subject of liquid steel pyrometry but only that part of the conference relating to oxygen lancing is reported here.



Curve	Plant	Blowing Rate cu. ft./ton/min.	Final Carbon %
A	Brymbo Steel Works (29-ton arc furnace)	11	0·05
B	Brymbo Steel Works (18-ton arc furnace)	15	0·04
C	Edgar Allen and Co., Ltd. (4-ton arc furnace)	75	0·02
D	A 25-ton Thomas-Bessemer Converter	170 (expressed as O_2)	<0·01

FIG. 1—INCREASED RATE OF CARBON REMOVAL WITH GREATER OXYGEN INPUTS

The manufacture of stainless steel and the manufacture of carbon, structural or "mild" steels, present different problems to the steelmaker using the oxygen lance. In both, however, the basis of the technique is to employ oxygen quickly to initiate and intensify the "boil" of the bath of metal in which carbon is oxidised and given off in bubbles of carbon monoxide. In the manufacture of stainless steel a new process has arisen, whereas in the manufacture of other steels oxygen lancing can be added to existing processes without much dislocation.

Stainless Steel

Oxygen lancing enables the manufacturer to employ in his charges up to 100 per cent stainless steel scrap, which was previously almost useless. This was because the close proximity of the carbon electrodes to the metal charge in an electric arc furnace makes it impossible to prevent a pick-up of carbon in the steel during melting, and subsequent oxidation of carbon by the addition of iron ore is not only slow but results in chromium also being removed. When the oxygen lance is used for removing the carbon, however, not only is the removal more efficient and the oxidation of chromium reduced but a considerable proportion of the chromium that is unavoidably oxidised can be recovered and passed back into the steel by the addition of suitable alloys at a later stage.

At the conference Mr. J. Nicol, of the Clyde Alloy Steel Company, Ltd., described the arrangements for oxygen lancing at his works. To provide the necessary high pressure and volume of oxygen the plant consists of six cushion receivers situated close to the furnace, fed by a 1in bore pipe from the liquid evaporator. They can be filled in about fifteen to twenty minutes. From the cushion receivers, a 2in bore pipe passes through a reduction valve to each furnace, where it is again divided into two outlets with separate control valves. It finishes as a 1in bore pipe. An orifice plate with manometer is inserted in the line and the flow is controlled by its indication. This installation has been successful for the requirements of two 10-ton arc furnaces.

The installation at the works of the English Steel Corporation, Ltd. was described by Mr. A. B. Cooper as having two evaporators, each with a capacity of 45,000 cubic feet, delivered to the furnace at 130–150 lb per square inch pressure through a 1in lance, giving about 22,000 cubic feet per hour to the steel bath.

One of the things that has become more apparent as experience has been gained is the importance of the rate of reaction in obtaining a really low-carbon content in the bath and the necessity for starting at a higher carbon content and not stopping the blow before the carbon has gone. In other words, it appears that the reaction must be given an impetus, which must be maintained until the process is complete. The practical effect at the Clyde Alloy Steel Company, Ltd., was, as Mr. Nicol stated, that it was advisable to aim to melt out not lower than 0·30 per cent carbon. At this figure the carbon/oxygen reaction started quite easily, while at a lower figure,

FIG. 2—THE BLOW IN PROGRESS

say 0·15 per cent, more difficulty was found in starting the reaction and keeping it going. It was usual to finish at a figure of 0·05 per cent carbon. The reduction was judged on the appearance of the flame. Mr. Cooper said it was advantageous to melt out at over 0·20 deg. Cent., and found that an approximate blowing time of fifteen minutes was usually necessary to bring the carbon down to 0·06 to 0·08.

A high oxygen input appears to be essential for effective operation. At the Clyde Alloy Steel Company's works, for example, the rate is 80 to 100 cubic feet per hour per ton of metal. The importance of a high rate of input applies also to heats of other steel than stainless.

To gain the effect the English Steel Corporation, Ltd., begin the oxygen blow by switching

FIG. 3—OXYGEN LANCING

* Communicated by the British Iron and Steel Research Association.

off the current before the material is very fully melted around the furnace banks, and little excess oxygen is used to melt the remaining unmelted scrap, providing the amount is not very great. This is thought to provide extra protection for the furnace roof and banks. At Clyde Alloy Steel Company the more usual procedure is followed and injection takes place after the melt and after the first slag has been partially removed. The current is switched off at the beginning of the blow. Mr. Nicol also reported that the 1in diameter tubes used for lancing are covered by small spigoted tiles, which are joined with air setting cement. Before protecting the lances it was usual to use six or eight lances with loss of time in changing and the danger of interrupting the reaction and losing impetus. Now a heat can be blown with a consumption of 8ft or 9ft of covered lance. The tiles used cost about 7d. each and save many times their cost in tubing, which besides being expensive is difficult to obtain.

When the oxygen blow has brought the carbon down to the right level there remains the necessity of reducing the chromium back into the metal from the slag. A new departure is evident here, too, which was discussed at the conference by Mr. D. J. O. Brandt, of the British Iron and Steel Research Association. Formerly additions of ferro-silicon were made, which "pulled" the chrome back into the metal, except for 2 to 3 per cent, which remained in the slag. This amount was made up by additions of low carbon ferro-chrome. During the last eighteen months or so the practice has spread of reducing the slag with a ternary alloy of iron, silicon and chromium, thus cutting down the use of the highly expensive low-carbon ferro-chrome in favour of an alloy in which the chromium is available much more cheaply.

Tables 1 and 2 show how this worked out when two sets each of five experimental heats using two grades of ferro-silicon-chrome are compared with eight heats using ferro-silicon

Use of Ferro-Silicon-Chrome in the Manufacture of Stainless Steel

TABLE I.—*Analyses*

Alloy used for reduction	Metal analysis				Elements added during reduction		Metal analysis after reduction	
	Before blow		After blow					
	%Si	%Cr	%Si	%Cr	%Si	%Cr	%Si	%Cr
75% FeSi	0·39	18·2	Tr.	14·2	1·55	None	0·31	16·0
46% Si FeSiCr ...	0·36	17·43	Tr.	13·83	1·51	0·80	0·31	17·0
32% Si FeSiCr ...	0·28	17·59	0·014	14·37	1·14	1·13	0·49	17·0

TABLE II.—*Recoveries*

Alloy used for reduction	Recovery of Cr from scrap	Cr added as low-C ferro-chrome	Final Cr content	Overall recovery of Cr
	Per cent	Per cent	Per cent	Per cent
75% FeSi	87·9	2·87	18·6	88·0
46% Si FeSiCr ...	92·9	1·27	18·06	92·7
32% Si FeSiCr ...	90·3	1·66	18·66	91·6

only. The ferro-silicon-chrome in this instance came from a source in this country, where two grades are made, but most of that used now is imported from Scandinavia and is confined to the 46 per cent silicon grade. The use of ferro-silicon-chrome can be seen from the tables to reduce the input of low-carbon ferro-chrome for two reasons; not only does it contain chromium, but the contained silicon acts more effectively as a reducing agent as it has a lower melting point and is more easily absorbed into the slag. At its present price the chromium in ferro-silicon-chrome costs about 1s. per lb, compared with the 1s. 7¼d. per lb paid for chromium in low-carbon ferro-chrome, which makes the substitution well worth while. The saving has been estimated to be of the order of £2 per ton in the manufacture of stainless steel.

On the future possibilities of the use of oxygen lancing in the manufacture of stainless steel, Mr. Nicol had this to say:—

"As stocks of stainless scrap are used up and since returns from stainless are, because of its qualities, low, compared with other types of steel, the oxygen process may have to be used in other ways to reduce the cost of producing stainless steel. One method which we have used in producing 12 per cent chrome alloy is to charge mild steel along with a mixture of Fe. Chrome. A usual mixture is 50 per cent low carbon and 50 per cent high carbon Fe. Chrome and this amount gives a melt in carbon of 0·50 to 0·60 per cent. No difficulty is experienced in reducing this to 0·05 per cent carbon with little loss of chrome. The procedure is similar to that for stainless scrap. Baths containing carbon as high as 1 per cent have been successfully dealt with.

"The manufacture of stainless steel by direct reduction of chrome ore has not been practised to any great extent in this country, although it has been used abroad. The results, I have heard, are not particularly good because of excessive slag bulk resulting in very dirty steel. It seems to me that to operate this process successfully very high temperatures would be required. Before the advent of oxygen lancing it would have been a brave man who would deliberately have taken his electric arc furnace up to, say, 1850 deg. Cent. Yet such a temperature would, I believe, give the direct process a chance of success. In the stainless oxygen process we get such temperatures whether we like them or not and there would appear to be a prospect of developing a process whereby some at least of the chrome could be obtained by charging a mixture of chrome ore and Fe. Silicon immediately after the oxygen blow, when the temperature is highest and the greatest use can be made of it."

To this Mr Brandt added his endorsement of the value of re-examining the methods of making chrome steels by reducing slags, to which has been deliberately added chrome ore, which is chromium in its cheapest form. The palmy days of cheap and plentiful stainless scrap were over and this country could not afford high imports of refined chromium alloys.

Another promising line of development discussed by Mr. Brandt was the control of bath temperature during lancing stainless charges, principally in order to conserve the furnace refractories. Curves plotted in the laboratory by D. C. Hilty (in the U.S.A.) for the stable chrome/carbon ratio against temperature immediately after the use of the oxygen lance indicated that it should seldom be necessary to raise the temperature to more than 1860 deg. Cent., as at this point the stable Cr/C ratio is about 360 : 1, that is to say, a bath containing 18 per cent Cr should remain in equilibrium with 0·05 per cent C. It might be possible, for example, to devise some method of charging scrap while the oxygen was passing, which might pay quite useful dividends in reduced costs and increased output. It would be useful, however, to re-examine Hilty's results, using the newly developed high temperature immersion pyrometers. Hilty had no such tool and used an optical pyrometric technique, which, while very ingenious, was open to question on the score of accuracy.

STEELS OTHER THAN STAINLESS

With special low carbon, mild and structural steels, again the rate at which reaction takes place is found to be a major factor. Mr. W. H. Everard, of Edgar Allen and Co., Ltd., described the manufacture (Figs. 2 and 3) of mild steels of less than 0·02 per cent C. The charge is melted and if necessary is carburised to 0·30 to 0·40 per cent C. The temperature of the bath is raised to 1600 deg. Cent. and the reducing slag removed. A lime-rich slag is then formed to facilitate dephosphorisation during blowing. The electrodes are raised and the blowing operation started. With a line pressure of 150/170 lb per square inch, oxygen is passed into the bath at the rate of 350 cubic feet per minute (80 to 85 cubic feet per minute per ton). As the temperature increases the bath begins to boil vigorously, the heavy, brown oxide fumes gradually decrease and are replaced by a long, hot carbon flame. The boil becomes still more vigorous and careful control of the oxygen input is needed as the violence of the carbon oxidation may cause slag and steel to boil over the furnace sill. When the flow of oxygen is discontinued the bath continues to boil steadily and persists while excess oxygen or oxides are present. The long, white carbon flame continues on further feeding with oxygen until the carbon in the bath falls to between 0·10 per cent and 0·05 per cent when the flame drops. To obtain carbon contents as low as 0·025 per cent it is necessary to blow for a further period, determined by experience. During this final stage of the blow there is no boil and the slag foams considerably. The electrodes are not lowered to the bath again during the remainder of the heat. The temperature of the bath at this stage is between 1660 deg. and 1700 deg. Cent., an increment of 60 deg. to 100 deg. Cent. resulting from the use of oxygen. The oxidising slag is now removed and the bath is deoxidised with ferro-silicon and aluminium, which are rabbled into the molten metal. A thin covering of limestone is added to the bath, degasification tests are taken and the heat tapped. The temperature of the bath before tapping falls to 1620 deg. to 1640 deg. Cent.

At the Clyde Alloy Steel Company's works the practice for the manufacture of mild steel for castings is somewhat different. A melt-out carbon of 0·25 to 0·30 per cent is aimed at and oxygen is injected at 50 cubic feet per minute per ton, while the power is kept on the furnace. It has been found that in these conditions carbon is easily removed at 0·10 per cent per minute, compared with a typical rate of 0·30 per cent in sixty minutes by the use of ore for oxidisation. Mr. Nicol stated that: "With a little practice the reaction can be stopped at approximately 0·10 per cent carbon with the manganese at 0·3 to 0·4 per cent. Excessive over-oxidisation can therefore be avoided."

Immediately after the blow the furnace is slagged, the second slag is formed, samples are sent for carbon and manganese and the cast is finished in the usual way.

The Clyde Alloy Steel Company had found it possible to reduce the bulk of slag by using oxygen, as sulphur and phosphorus contents are low in the scrap used and carbon is, of course, removed by the oxygen. A slag weight of about 1 to 1½ per cent of the charge weight, compared with a usual 3 to 4 per cent, gives satisfactory results and helps to cover the cost of the oxygen.

The method of using the oxygen lance in manufacturing structural steels is substantially the same as that used in the manufacture of mild steels. The time gained in removing the carbon quickly, however, is partially lost because of the necessity of working to close limits and thus having to wait for chemical analyses.

Another way altogether of making stainless steels with very low carbon contents (0·03

per cent maximum), without the use of oxygen, was described to the conference by Mr. F. T. Bagnall, of Samuel Fox and Co., Ltd. Essentially the method consists of premelting light carbon steel scrap, in which there is only a trace of silicon in a basic-lined high-frequency furnace, which produces a very low carbon steel base before adding alloying elements—the bulk of the production going into stainless steels. The carbon content of this premelted base is usually of the order of 0·01 to 0·02 per cent, so that it is possible to achieve 0·03 per cent carbon in the finished stainless steels, provided ferro alloys of sufficiently low carbon are used.

Conclusions

The advantages oxygen lancing affords in saved time and increased output have been indicated above, as permitting the removal of carbon at a rate fifteen to twenty times the rate permitted by oxidation by ore additions. In concrete terms this can reduce the time of a 10-ton charge of stainless steel by perhaps three-quarters of an hour, which is some 15 per cent of the time taken by a typical heat. On the subject of steel quality, Mr. Nicol specifically stated :—

"We are satisfied that the advantage lies with oxygen. We have a smaller incidence of hair-line cracking, our foundry people are satisfied with the metal. Surfaces on stainless ingots are better than at any time with ordinary practice, possibly because the metal is in a more fluid state when teemed. Results on the rolling of stainless slab ingots for plates have shown a real improvement."

This opinion the conference seemed generally to endorse.

Discussion

During the discussion the suggestion that a method of direct reduction of chrome ore might be developed came in for comment. Mr. G. A. Wood, of the English Steel Corporation, Ltd., thought more work had been done on the Hamilton-Evans process than Mr. Nicol had allowed, and Mr. A. A. Munro, of Imperial Chemical Industries, Ltd., mentioned that at his works there were tanks in use which had been made from metal thus produced some thirty years ago by Colvilles. Mr. J. L. Harrison, of the British Oxygen Company, Ltd., commented that he himself had carried out some work on the adaptation of this process by the use of oxygen but had found difficulty in the formation of spinels by the combination of chrome with magnesite. He did not know how they might be broken down and until this was solved he did not think that more than 50 per cent of the chrome could be recovered. Mr. D. J. O. Brandt, British Iron and Steel Research Association, suggested that the chrome could be got out of the slag in these circumstances and that this was indeed done in the manufacture of ferro-chrome. Mr. W. Keen, of William Jessop and Sons, Ltd., had experience of operating the Hamilton-Evans process many years ago in the manufacture of rustless iron for golf clubs. When the metal was tried in sheet form, it gave a "salt and pepper" effect.

Mr. Nicol replied that he knew of experiments on the Hamilton-Evans process and he was glad to know from Mr. Munro that the metal made by Colvilles many years ago had been satisfactory. The fact remained that in the direct reduction process there was insufficient separation of metal and slag, which could result in a dirty product. All he was suggesting was that the higher temperatures now obtainable by oxygen injection opened up the possibility of better slag-metal separation. On this point of the yield of chrome on reduction from the slag, Mr. Wood mentioned that the comparatively poor results sometimes obtained came from the fact that chrome could lie on the metal and the slag in the normal manufacture of stainless steel, just as it did in the Hamilton-Evans process. In normal manufacture vigorous rabbling could often obviate poor yields.

Mr. W. H. Everard, of Edgar Allen and Co., Ltd., took up the temperature control points raised by Mr. Brandt in his paper. He agreed that there was evidence that an optimum rather than a high temperature should be aimed at. Indeed, it was possible that we had overdone the achievement of high temperature altogether. At his works they now judged the temperature by the appearance of the flame and the furnace and fed scrap through the side doors while oxygen was still being injected. He was quite certain that this had substantially reduced hearth erosion by high temperatures and they now could undertake to make 18/8 austenitic steels in alternate casts.

Mr. Harrison agreed with this point and reported that one firm of his acquaintance did five and six consecutive heats of austenitic steel regularly by putting in a cooling charge immediately blowing was completed.

Mr. A. Cooper endorsed this and said that the English Steel Corporation, Ltd., was able to undertake very arduous programmes of austenitic heats. He was convinced that a cooling feed immediately after blowing contributed to their success. They sometimes added a full ingot at this stage.

Mr. C. W. J. Crawford, British Iron and Steel Research Association, said that this raised the question of the necessity for the work on very high temperature measurement that the Association was now undertaking. Did steelmakers at this conference still think that this work was worth while? Mr. Everard replied that he was convinced of its value. Even though the bath might be cooled, it was still at a higher temperature than could be measured with available equipment. Temperature control was necessary and control was impossible without measurement. Mr. Wood expressed surprise at the heavy reduction of sulphur reported by Mr. Nicol when the metal was poured into the ladle. Mr. Nicol replied that he had not meant to imply that this was due directly to the use of oxygen. He thought that the high temperature achieved along with the turbulence, were the real reasons. His experience was confirmed by Mr. J. McCafferty, of William Beardmore and Co., Ltd., and Mr. T. Harris, of Brymbo Steel Works, Ltd. Mr. Harris said that when they had used two ladles, the contents of one of which were returned to the furnace, it was found that the greater turbulence reduced the sulphur content from 0·015 to 0·005 per cent on transfer, which was only reduced to 0·003 in the furnace during subsequent refining.

Mr. G. T. Harris, of William Jessop and Sons, Ltd., said that in the use of oxygen injection in the manufacture of highly alloyed steels for gas turbine engines they had found that there was no loss in cobalt, nickel, molybdenum; there was a 5 per cent loss of chromium and a 28 per cent loss of niobium, even when a considerable amount of niobium was recovered from the slag by the use of ferro-silicon.

Interest was expressed in Mr. Nicol's method of covering his lances with refractory tiles. Mr. N. Tranter, of F. H. Lloyd and Co., and Mr. I. Strode, of Glanmoor Foundry, both reported that they had had success with refractory coatings on lances. Mr. Strode said that originally they had used two or three 20ft lengths of lance with consequent interruption to the blow before they had adopted a refractory coating; now they only consumed 5ft per blow.

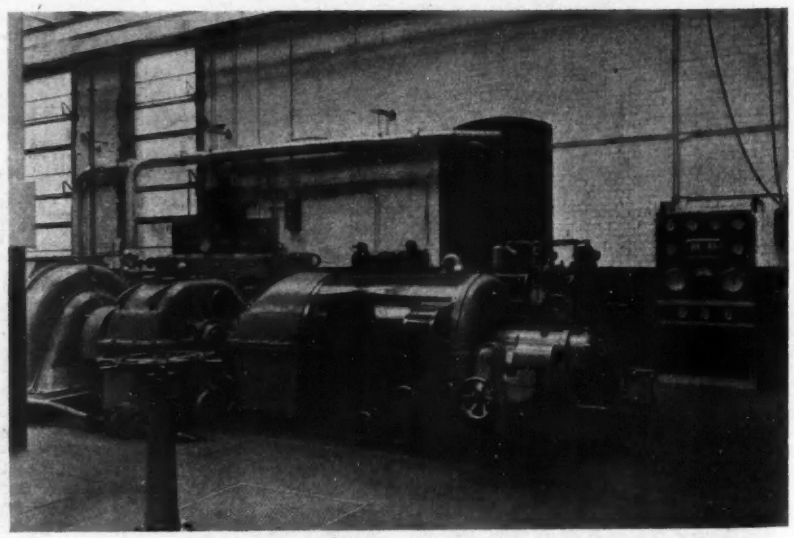
Mr. G. L. Willan, of the Electric Furnace Company, Ltd., asked if there were any suggestions at the conference as to modifications in the design of electric furnaces that the the use of oxygen lancing might make desirable. For example, would it be likely to alter the ratio of bath diameter to depth? Mr Everard had mentioned that the side doors in his furnace were very useful. Was that likely to be a future demand? Mr. Everard did not think that it would be practical to design a furnace specially for oxygen lancing Mr. Nicol agreed but added that a very tight-fitting door with a clamp or cam to keep the door up against the jambs would be useful to the furnaceman. Mr. T. Harris thought that the design of fume extraction plant needed more attention than the design of furnaces.

Finally, Mr. Munro, from Imperial Chemical Industries, Ltd., questioned Mr. Nicol's statement that stainless steel made with oxygen injection was cleaner. Mr. Nicol replied that this seemed quite logical to him because the higher temperatures tended to separate the slag from the metal.

Electricity Supply in a Furniture Factory

IN a private power station owned and operated by Harris Lebus, Ltd., the furniture manufacturer, wood waste from the factory is used as fuel for the boilers, which provide steam for a maximum generating capacity of 5000kVA. Pass-out steam provides for the requirements of factory heating and processing, while the electricity generating capacity of the power station makes the firm independent of power cuts.

The company, which has been established in Tottenham for half a century, has a furniture factory, which is believed to be the largest in the world, with a floor space of over one million square feet on a site of 43 acres. Progressive development in the use of motor-



2500 kVA Turbo-Alternator

driven machines, power conveyors, electrically-heated glue dryers, exhaust fans and high intensity lighting in all departments has resulted in a rapid increase in electrical demand. To-day, the maximum load is in the region of 4000kVA, with an annual consumption of about 7 million units.

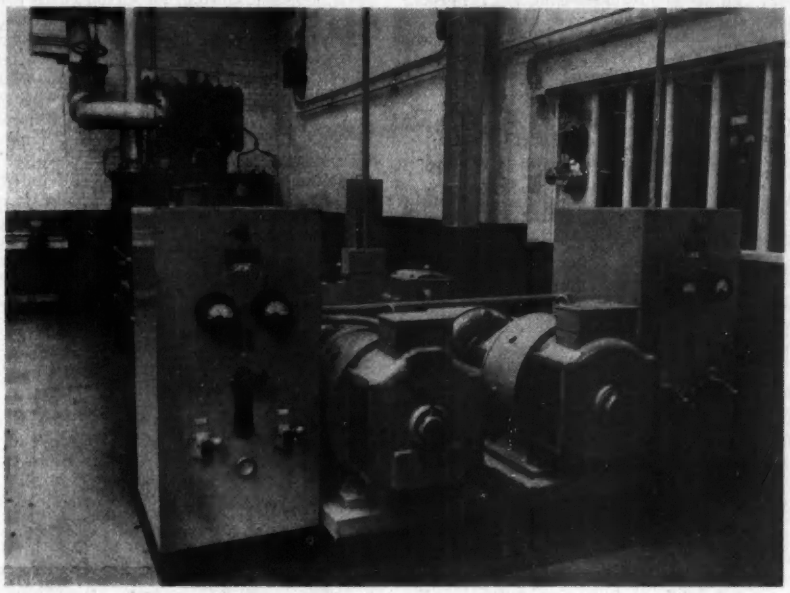
From its early days the company has been burning wood waste to produce electrical power, with steam for the factory available from back pressure or pass-out prime movers. Electricity was generated first at 150V d.c. and, later, with additional generating plant, at 240V d.c. With the increasing application of motor drives, the rapid rise in load demand made it necessary to take a 400V, a.c. supply from the local authority. A new 400V, a.c., three-phase, four-wire works' distribution system was, therefore, installed, together with reversible motor-generators to couple the d.c. and a.c. systems and allow for the exchange of power and for the d.c. generating plant to operate in parallel with the incoming supply.

In 1934 a Parsons 2125kVA, 415V turbo-alternator was installed to enable the whole of the system to be changed over to alternating current. The set was designed for a steam input of 42,000 lb per hour, at 150 lb per square inch pressure and 550 deg. Fah. temperature, and had a pass-out capacity of 34,000 lb per hour. It was also equipped with a small condenser to obtain maximum efficiency of operation when pass-out steam was not required. The turbo-alternator set was operated in parallel with a 275kVA vertical, two-stage, non-condensing Belliss and Morcom steam engine, 415V alternator set. In 1936, to meet the increasing load, a Fraser and Chalmers-G.E.C. 2500kVA, 415V turbo-alternator set, with condenser, was installed. This set, which is illustrated, has a steam input of 33,000 lb per hour, 150 lb per square inch pressure, 550 deg. Fah. temperature and a pass-out capacity of 33,000 lb per hour.

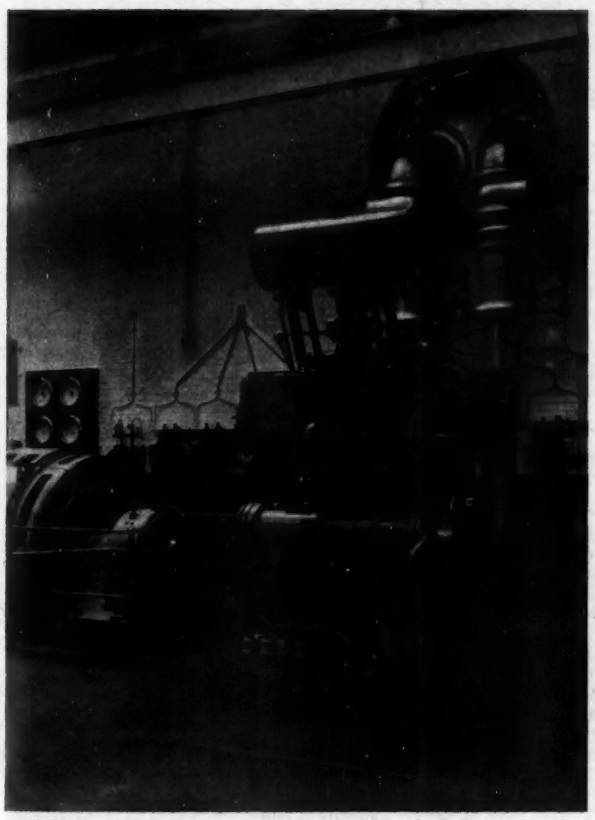
Steam for the turbo-alternators is produced from Babcock and Wilcox wood-fired boilers. There are four such boilers, two of which (installed in 1907) have a capacity of 10,000 lb per hour each; one, installed in 1935, has a capacity of 16,000 lb per hour, and the fourth, installed in 1941, has a capacity of 17,000 lb per hour. This bank of boilers, with a total capacity of 53,000 lb per hour, is probably one of the largest wood-fired units in the country. In addition, there is a bank of three Galloway boilers that are used to supply factory steam when the demand is heavy. These boilers are oil-fired, having been converted from coal burning in 1946. Each boiler has a capacity of 10,000 lb per hour, so that, with the wood-fired boilers, the total steam capacity is 83,000 lb per hour. The wood waste is fired in specially designed furnaces, all large off-cuts being hogged to fine size before admixing with chippings and sawdust. A conveyor system is installed to deliver the mixed wood waste to storage and to extract from storage via automatic weighers to the boiler furnaces, in which combustion takes place almost entirely in suspension.

The winter total steam demand for generating plant and factory is in the region of 80,000 lb per hour, when the consumption of wood waste is some 350 tons per week. General operating practice is to generate in the summer months up to capacity, using steam from the wood-fired boilers and running the turbines as condensing units. In winter the turbines are operated primarily to produce pass-out steam for space heating and factory processing.

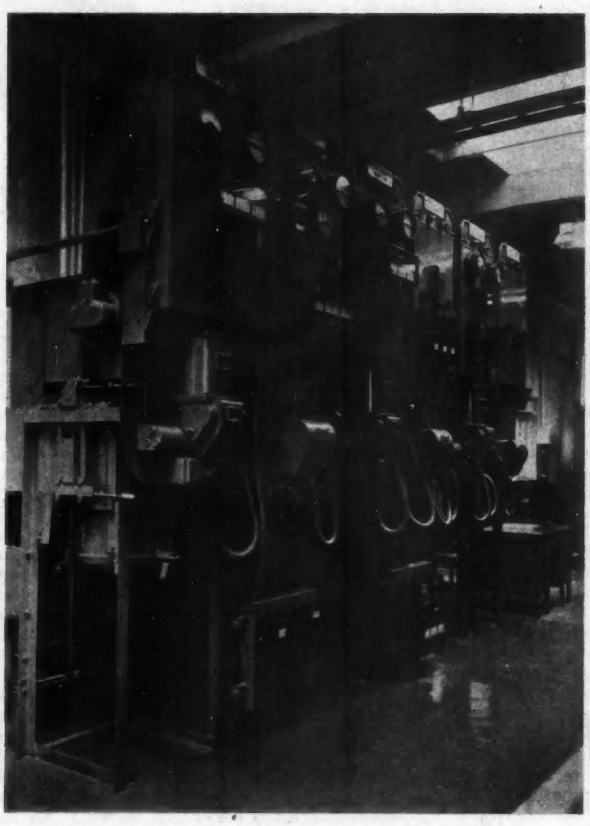
Flexibility of operation is achieved by running the generators in parallel with the B.E.A. network (through two step-up transformers), so that a heavy demand for steam from the



25kW Motor Generator Set



Generator Transformer



6·6kV Switchgear

factory can be met by increasing the generator output, shifting the load from the authority's system. During peak hours in the winter months no energy is taken from the B.E.A. Then the incoming feeder breaker is open and an interlock controlled by a time switch prevents the breaker being closed. To meet the electrical demand when the B.E.A. supply is not available, additional steam is generated as required from oil-fired boilers.

With the combination of steam generating plant, steam heated factory equipment and a bulk electricity supply, the plant is operated at a high overall thermal efficiency and without electrical load-shedding. The system is operated from a main control room adjacent to the power station.

Electricity Distribution System

For several years the 400V distribution system was developed with a main switch room adjacent to the power-house, from which the medium-voltage distribution feeders went out to boards in the works, and were controlled by Crompton Parkinson "Klad" switchgear units with a breaking capacity of 25MVA. During the war extensions of the local authority's network increased the short-circuit power available to nearly 50MVA, so that it became necessary to undertake a modernisation of the distribution system as soon as conditions permitted. In any case, with increasing load and expansion of the works, it was neither practicable nor economical to continue extending the medium-voltage system. After detailed investigation it was decided to change to 6·6kV distribution with step-down substations at load centres in the works. This decision involved the installation of a 415/6600V step-up transformer for each alternator and two 11/6·6kV transformers to step-down the incoming bulk supply for the works' distribution system and allow for the alternators to operate in parallel with the incoming supply.

The choice of 6·6kV for the distribution voltage was determined mainly from a consideration of the short-circuit capacity. The present short-circuit power available at the incoming substation is given as 150MVA and, with the addition of the 2500kVA, 2125kVA and 275kVA alternators in parallel, the total short-circuit power would be about 189MVA. This would have necessitated the use of 250MVA switchgear. It was decided, therefore, to provide additional impedance with an 11/6·6kV transformation and 150MVA, 6·6kV switchgear. With this arrangement the 150MVA switchgear installed should be satisfactory for many years, even when the B.E.A. extends its distribution network and increases the short-circuit power available at the incoming supply. With the maximum short-circuit power on the 6·6kV system in the region of 55MVA, there is adequate margin to allow for further development of the external network.

The reorganisation of the power supply system was planned and carried out by the engineering staff of Harris Lebus, Ltd. The work included the installation of a new 11kV, 150MVA breaking-capacity three-unit switchboard controlling the incoming supply from the Eastern Electricity Board, and the primaries of two 11/6·6kV, 1000kVA transformers. The transformers, supplied by the British Electric Transformer Company, Ltd. (in association with Crompton Parkinson, Ltd.), are outdoor "ON" units, equipped with double-float Buchholz protectors.

The 11kV switchgear, supplied by Crompton Parkinson, Ltd., is "MCA2" metalclad compound-filled, with vertical drop-down isolation. The structure is of heavy welded steel, braced to prevent movement or distortion and providing accessibility for maintenance. The incoming feeder unit has a normal current rating of 200A, manual closing, and overcurrent protection. The two transformer units have a normal current rating of 100A, solenoid closing, Ferranti-Field earth-leakage protection and overcurrent protection, with relays tripping both 11kV and 6·6kV circuit breakers. The secondaries of the transformers are connected to 6·6kV "MCA2" compound-filled switchgear units of normal current rating 100A, solenoid closing, restricted earth leakage and three-phase reverse power protection.

For stepping up the alternator voltage to 6·6kV there are two "OFW" transformers (forced oil circulation with water cooling) of ratings 2200kVA and 2500kVA respectively. One of these transformers is shown herewith. The medium-voltage primary is connected directly to the alternator, so that the alternator with transformer forms a combined unit, with unit protection and control. "OFW" transformers were installed because the space available was limited. The transformers are delta-star connected with the neutral point earthed solidly. Each alternator-transformer unit has Merz-Price current balance protection, arranged to operate the 6·6kV transformer circuit breaker and a field suppression switch, back-up overcurrent protection, and single-phase reverse-power protection.

For the power-house auxiliary supply two 750kVA outdoor "ON" transformers are installed, together with "MCA2," 6·6kV, 150MVA, 75A switchgear and medium-voltage 25MVA, 400A switchgear. On the 6·6kV side, the transformers have Ferranti-Field earth leakage protection, and are also equipped with Buchholz two-float protectors.

The 11kV switchgear is installed in an annex to the main switch and control room, which accommodates the 6·6kV switchgear along one side, with a flatback switchboard on the other. This switchboard was reconstructed and re-equipped for the control of all alternators and the 11kV and 6·6kV switchgear; it was also fitted with new medium-voltage 25MVA oil-circuit breakers controlling transformer secondaries and house feeder circuits. For controlling the outgoing ring-main feeders to the works, the 6·6kV switchboard includes four "MCA2" 150MVA, 300A units, spring-closed, with Ferranti-Field earth leakage protection and overcurrent protection.

The new 6·6kV distribution system involved the installation of six works substations and 1700 yards of Crompton 6·6kV, 0·25 square inch cable, together with the rearrangement of the existing medium-voltage distribution cables.

In each distribution substation there is a "MCA2" ring-main unit, a 750kVA "ON" transformer, and a 400V, three-phase, four-wire "Klad" switchboard. The ring-main unit is similar in construction to the other switchgear, but with oil-immersed load-breaking isolating switches. The chamber is of welded construction, with a removable top lid carrying, on the underside, the standard isolator socket assembly to engage the front plugs of the circuit breaker. The isolating switches are externally operated from the front and the correct sequence of operations, "on," "off" and "earth," is ensured by simple interlocking. Split cable-boxes on both sides of the isolator chamber are provided for the ring-main cables and each box is reversible for either top or bottom entry. The unit is equipped with spring closing and overcurrent protection.

It was possible to make use of practically all the existing medium-voltage cable for the system fed from the 6·6kV substation. The work involved shifting most of the cable runs in some way or other and we learn that no faults have been experienced since the alterations were carried out. An additional 1000 yards of Crompton medium-voltage 0·4 square inch cable, together with a quantity of 1·0 square inch single-core cable for transformer connections, were also used.

The high-voltage ring-main system consists of Crompton S.W.A. served lead-covered cable of the semi-drained type, since, except for a 60ft run under the railway, which crosses the works area, all the high-voltage cable runs are overhead. This cable system was installed and all joints made by the company's engineering staff, under the supervision of the electrical engineer. Several lengths of 0·75 square inch, 6·6kV cable were also installed to connect the two halves of the 6·6kV switchboard in the main control room.

"Klad" Medium Voltage Switchgear

The reorganisation of the distribution system was started in 1948, but the actual changeover did not begin until February, 1950, and was completed by August of the same year.

Emergency Supplies

For emergency supply, or for use during periods of maximum load in the winter months, the steam-engine-driven 275kVA, 415V alternator can be connected to the busbars supplied by the house transformers, which can then be used to step-up to 6·6kV and thereby provide a minimum supply for the works' distribution system. During periods when the public supply frequency is falling the 275kVA set is also operated to maintain a steady 50 c/s for the power-house and boiler-house auxiliary motors. These motors are normally supplied from the house transformers, but they can be isolated from them and connected to the 275kVA alternator by means of a changeover switch.

Because some of the wood-working machinery operates at very high speeds, for example, 24,000 r.p.m., the risk of its continued rotation during a black-out resulting from an electricity supply failure would be so serious that, throughout the works, there is a pilot lighting

system connected to separate mains, fed directly either from a steam turbo-generator or a petrol-driven generator that is operated continuously during after-dark working hours. The petrol engine set is connected to a switchboard with a changeover switch, so that it can be used in the event of a complete power failure for operating the d.c. closing solenoids of the high-voltage switchgear. Normally the d.c. supply is obtained from two Crompton Parkinson-Verity 25kW, 230V, d.c. motor generator sets, also illustrated. They supply the direct current required for certain factory drives. For high-frequency machine tools Brook frequency changers are installed to provide 75, 125 and 200 c/s.

Referring to the main distribution system, the ring mains are operated as radial feeders by opening the appropriate ring-main isolator. All the distribution transformers are earthed solidly, as each supplies a separate medium-voltage system with no interconnection to other parts of the network. The substation transformers are equipped with Buchholz two-float protectors, with remote indication in the control room to give warning of operation. The ring-main unit circuit breaker and "Klad" switchboards are also equipped with remote indication of any switch tripping. A 24V "Nife" battery is installed in each substation for tripping operation.

For safety of operation and maintenance there is in use a single-line high-voltage system diagram in the form of a keyboard, so that when a key is removed the control engineer can tell at a glance where work is being undertaken on high-voltage equipment. All such work is carried out on "the permit to work" system.

This article is based on information supplied by Mr. J. J. Chase, the electrical engineer of Harris Lebus, Ltd., and by Crompton Parkinson, Ltd.

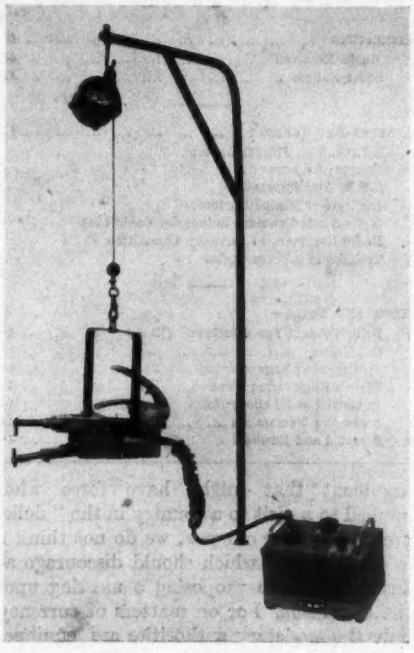
A Portable Spot Welder

THE accompanying illustrations give an impression of a portable spot welding equipment that was exhibited by the A.R.O. Machinery Company, 18, Madrid Road, London, S.W.13, at the recent Engineering, Marine and Welding Exhibition at Olympia.

The equipment consists of two main units: the "pliers" comprising the welder proper, and the electromagnetic timing device. The latter is carried in a screen-protected box fitted with control knobs, whereby the welding time can be preset from 0·1 to 1 second. A four-core t.v.s. cable connects the pliers with the timing controller. The remaining two items shown in our illustration—the winch and gantry supporting the pliers—are included for convenience only; they do not form part of the equipment.

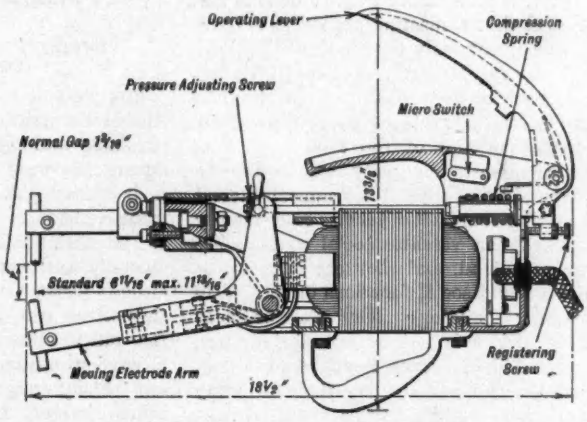
Referring to the drawing, which shows the general arrangement of the welding pliers, it will be seen that the upper or fixed electrode arm is held by a nut and bolt in a sleeve, whence it can be removed readily. The lower or pivoted electrode arm is actuated by the actuating lever, which forms the upper part of the handle grip. A rod carrying a helical spring links the operating lever and the bell-crank lever which carries the lower arm. The spring provides the electrode pressure and there is an adjusting screw on the front end, whereby the pressure can be varied. Behind and below the operating lever there is an adjusting screw, whereby the electrode gap can be varied.

When the operating lever is fully depressed a micro switch in the fixed part of the handle is actuated and the welding sequence begins, under the control of the timing device: a



PORTABLE SPOT WELDING EQUIPMENT

contactor is operated to initiate the welding current and, at the end of the predetermined interval the welding current is interrupted by the contactor. Because of the high current and electrode pressure the welding time is short (0·1 to 1 second), which makes it a simple matter to ensure that the pressure period shall exceed the welding period, thereby improving the forging of the welded spot.



SECTION THROUGH WELDING "PLIERS"

The welding transformer is carried in the body of the pliers and the secondary current is stated to be 5500A when welding 2 by 19 S.W.G. mild steel. The no-load secondary voltage is given as 3·1V and the welding capacity as 2 by 14 S.W.G.

The normal electrode gap is 1 3/16 in but the gap can be increased to 3 3/16 in by releasing the upper arm of the bell-crank lever carrying the lower electrode. Our drawing shows the overall dimensions of the pliers; the weight is 22 lb. The standard equipment is designed to operate on a 220V, single-phase, 50 c/s supply, and 15/20A fuses are recommended.

Newcomen Society Autumn Meeting

SEEING that this year marks the 150th anniversary of the incorporation by Act of Parliament in 1801 of the Surrey Iron Railway, the first public goods railway in the world, nothing seemed more appropriate to the Newcomen Society than to devote a day's meeting—Friday, September 28th—to it and to its extension, the Croydon, Merstham and Godstone Railway, incorporated 1803, by making a trip over the route.

Assembling at the Institution of Mechanical Engineers, Storey's Gate, the party proceeded by coach to Wandsworth, where there was once a dock and basin at the mouth of the Wandle, now filled in, and the site of the South Eastern Gas Board's Works. Thence the party proceeded along Garratt Lane, which now bears little trace of the railway to Mitcham. Mr. Christopher Chart, of Messrs. Chart, Son and Reading, Surveyors, established 1769, obligingly showed the party a large collection of surveys and maps touching upon the route of this railway, A visit to the Eagle Leather Works of John S. Deed and Sons, Ltd., Willow Lane, Mitcham, followed. Here three undershot waterwheels and fulling stocks were, by the courtesy of the firm, shown at work by Mr. H. Sewell, an old windmill-wright; the speed of one of the wheels was timed at 20 r.p.m.—good going!

The track of the railway was followed across Mitcham Common to Croydon; here lunch was served. The route afterwards led to Purley, where, in the Rotary Field, the trace of the permanent way is very distinct. The high spot of the trip was encountered at the Coulsdon and Purley Central Library, where Mr. K. M. Newbury, F.L.A., has arranged, with the help of members, an exhibition of maps, MSS., illustrations, relics, &c., of the railway, more extensive than anything that has previously been got together. This collection has been made to mark the Festival of Britain and will be open to the public till the 20th inst. At Coulsdon, in the grounds of Cane Hill Mental Asylum, the remains of the embankment that crossed Chipstead Valley Road were seen. A detour was made to Chipstead Parish Church to see the noble monument to Sir Edward Banks, and his tomb in the churchyard. He was the contractor for the line. It is interesting to record that the tomb was reconditioned in 1933, largely through the exertions of the Society. Tea was taken at Cosy Corner Cafe, Hooley, built on the filled-in cutting of the railway and adjoining the bridge, still in good condition, that carried Dean Lane over the line. The next stop was at Fox Shaw, where, by the courtesy of the owners, Mr. and Mrs. J. Francis, the party was admitted to see the house, which, at the time of the construction of the line, was an inn. Here it was that Banks entertained a party which had assembled to see a horse draw a load of 55 tons along the line to Croydon, 6 miles in one hour, nineteen minutes. Perhaps we ought to insinuate here the information that the grade was a descending one of 1 : 120! At the Jolliffe Arms, on the other side of the road from Fox Shaw, the Surrey County Council is praiseworthily establishing a permanent memorial, composed of sleepers and rails from the line At the terminus, the Grey Stone Lime Works, Major E. W. Taylerson, M.I.Mech.E., managing director, member, showed the party the Millhouse offices, stables, cottages, &c., of the railway. From here the coach took the party direct to town, terminating a day of concentrated interest, which was favoured by fine weather.

CONSTRUCTIONAL STEELWORK PRODUCTIVITY TEAM.—An erroneous statement was made in a Seven-Day Journal Note under this title in our issue of September 1st. The address of Joseph Parks and Son, Ltd., is Northwich, and not Wolverhampton, as printed. Our apologies are due to that firm.

THE ENGINEER

Vol. CXCII OCTOBER 5, 1951 No. 4993

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INSTITUTION SUMMER MEETINGS ABROAD

IT will be obvious enough from the fact that we continue in this issue an account of the proceedings of the "Iron and Steel Institute in Austria" that we recently returned from a visit with that Institute to that country. We hope, too, that we are managing to convey to readers in that account how interesting the members found their visit and how cordially they were received. The Iron and Steel Institute makes a regular practice of holding summer meetings abroad once every two years. Another "learned society" in this country which has a similar custom is the Institution of Naval Architects. That body, of course, has a strong international element amongst its membership. For British ships predominate upon the seas and Britain still builds each year over 30 per cent of the new tonnage coming into use. But the Iron and Steel Institute is also an international body. For, as Sir Charles Goodeve remarked in a speech at Leoben Hochschule in Austria, "those who study iron and steel are a fraternity of peoples unseparated by frontiers." Other institutions in this country, notably the major engineering institutions, less often take their members abroad. Whilst these three Institutions generally hold summer meetings, they customarily take place in this country. The Institution of Mechanical Engineers held a meeting in Canada and the U.S.A. in 1932, and it had arranged to go to the United States in 1939, a visit that had to be cancelled almost at the last moment owing to the outbreak of war. But since the war no meetings abroad have been arranged. None of those institutions, therefore, has any regular practice of holding meetings elsewhere than in this country. We rather wonder why: for engineers, just as much as those who study iron and steel, form "a fraternity of peoples unseparated by frontiers."

At this time it may, perhaps, be held that to take a large party of members abroad is unpatriotic in that scarce foreign exchange will be used up. That is an argument that might have force when applied to a visit to a country in the "dollar area." But for our part we do not think it is an argument which should discourage an Institution from proposing a meeting upon the Continent. For on matters of currency, only the monetary authorities are equipped with knowledge upon which to base a sound decision as to whether such a meeting is or is not reasonable. Moreover, it can certainly be argued very firmly that the benefits to be gained by members through winning some knowledge of engineering practice abroad and more particularly upon the Continent are very well worth the expenditure of foreign exchange involved. Again, it may be thought that relatively few members out of the whole membership of an Institution could afford the cost. That, no doubt, is unarguably true. But it is not suggested that a meeting abroad should be held every year, only that it should be held sufficiently regularly for members to become accustomed to such visits and to become aware of the advantages they offer. For, as the experience of the Iron and Steel Institute shows, not only will works be visited and other objects of technical interest be seen that could not otherwise conveniently be viewed, but valuable social contacts are built up abroad, and they are built up at receptions and social functions, often held in interesting buildings that the ordinary private visitor is not permitted to enter, or may, indeed, never have heard about. For those who have to pay their own way unsupported by their firms, such visits—which broaden the mind in other senses besides the technical—also offer the advantage that all troubles of luggage, accommodation and travel are taken care of for them. For womenfolk they become, attractively, holidays abroad. Nor is another trouble that can be anticipated insuperable. On the Continent there is always a language difficulty. It is not always possible in taking parties round a works for the management to provide guides who are both well-informed and have a good command of English. But the difficulty can easily be exaggerated. Some of those being taken round often prove well enough informed to explain to others; and some will have enough command of the national language to act as interpreters in case of need. Experience reveals that the situation works itself out satisfactorily. Indeed, it is remarkable how far observation, helped by a few words in broken English and aided by some prior experience, can go in explaining quite unusual technical operations.

To some extent the regular meetings abroad of the World Power Conference meet the needs of engineers for international experience. But that body is so very large and so very international, and its meetings are so often held in such very distant places, that it cannot provide for that intimate social as well as technical relationship between hosts and guests, and between the guests themselves, that only the meeting of a smaller body nearer home can provide. For our part, then, we think our major engineering institutions should give attention to the holding of such summer meetings abroad at an early date. For the time is propitious. Continental nations have experienced more difficulty than Britain in re-equipping and reorganising works. But, though much old plant still remains, much new plant has also been installed and great schemes of power development are in train. Engineers in this country, we believe, would benefit greatly by seeing how Continental engineers are tackling problems similar to their own. Moreover, the means for ensuring that a meeting abroad would be valuable exist. Through the Conference of Engineering Societies that has recently come into being amongst the Western nations, an invitation could be arranged and a satisfactory programme be worked out. For some time the major engineering institutions here have been sponsoring arrangements for groups of students to tour abroad, and for foreign students to come to this country. Is it not time that similar arrangements were made for their senior members?

IMPROVEMENTS IN AIRLINE OPERATIONS

THE annual reports of the two British Airline Corporations certainly showed a remarkable and very welcome improvement during the year ended March 31st last in their operating accounts. For this improvement credit is no doubt due in the first place to increasing skill in management, and secondly to the greater homogeneity of their aircraft fleets, though, as the Corporations themselves would be the first to admit, the public themselves by their steadily increasing patronage of air travel facilities are chiefly responsible. This growth in public interest has been especially notable in America and Australia during recent years, where the ratio of air passengers to population has shown a tenfold increase in a single decade: in the U.S.A. from 1 in 100 to 1 in 10, and in Australia from 1 in 60 to 1 in 6. In the face of such figures the more air-minded countries must be nearing the moment when this attitude on the part of the public will show itself in a very substantial reduction in the sums which the national exchequers have to provide to balance the accounts. We learn from the current British Corporations' returns that the combined subsidy from the State, which in 1949–50 had been over £9 million, is now

less than £6 million—a most welcome improvement. It appears that during the year the number of B.O.A.C. passengers rose by as much as 29 per cent, and by 23 per cent in the case of the B.E.A.; incidentally, if one is to credit a writer in the columns of *The Times*, one in every nine of the B.O.A.C. travellers was not human, the passenger list including lion and tiger cubs, jackals, bears, hyenas, and even crocodiles—these, however, are no doubt accommodated in airliners of the freight-carrying variety to prevent untoward incidents! As *The Economist* pointed out some years ago, the most satisfactory yardstick for the comparative performance of the different air-lines is the ratio of the capacity ton-miles to the number of employees. This assumes, however, the use of a uniform criterion as regards the inclusion in the figure for employees of those administrative agents who serve the airlines in an auxiliary capacity. Even so, it serves as a useful measure of efficient operation from year to year in any given air-line organisation. Hence it is very encouraging to find that for the B.E.A. this important figure has almost doubled during the last three years, rising from 3700 to 7300; and that in the B.O.A.C. it has risen during the same period in almost the same ratio, namely, from 5300 to 9700.

A question inevitably raised by what has been revealed of recent military designs is whether the wing structure which one has come to look on as normal may not change substantially in the near future. One has watched the huge "Brabazon" type, which seemed so desirable only a few years ago, give pride of place to the more modestly dimensioned, but far speedier, "Comet," whilst more recently still the idea is spreading that something can be learnt by airline pioneers from what is known as the Delta wing. Much secret experimental work has been undertaken on this form of wing and some of its features have become known, for it is, after all, hard to conceal all the details of a new wing form once an aircraft is in flight. The use of this wing, although mainly introduced to serve military needs, can, it seems, be adapted for service in civil aviation. The general objective is the better service given at high speed and high altitude by wings of pronounced sweep back and considerable chord at the root—so giving the distinctive triangular plan form. Enough has been learnt to indicate that in such a design there may profitably result a useful lowering of the wing loading which, if confirmed in practice, should lead to a welcome change towards a materially lower landing speed. This would promise a less lengthy run on landing and greater safety for passengers and crew. Moreover, the considerable space within such shapes of wing enables the jet engines and their fuel tanks to be very comfortably and cleanly housed inside the structure. In this way it may prove possible to provide, without any increase in risk, the high speeds desired by airline operators and greater economy in providing and maintaining aerodromes. The objective of greater safety is still a much-needed requirement. A comparison published recently in one of our aeronautical contemporaries contrasts the fatal accident ratios per 100 million passenger-miles in Britain and the U.S.A. The latter country is shown to be much ahead of Britain in this respect; the American accident ratio being more favourable by an average factor of about four to one. What this big difference is due to is certainly worth investigation by our authorities. No doubt the weather vagaries of this wind-swept island may be responsible for much of it; whilst flying aids are much easier to organise, and to make foolproof, when intricacies of frontiers and language differences are not continually cropping up; and easier, too, when the organisation is on a larger and more important scale. That there is room for some measure of official enlightenment seems evident from the surprising claim made, according to a *Times* reporter, by Sir Hartley Shawcross, during the inquiry into the crash of a "Viking" in October of last year, that in 1950 the British air fatality ratio per 100 million passenger-miles was smaller than that in any other form of transport! That ideal has however yet to be reached.

A graphic picture of the present position of air travel in U.S.A. was given in a lecture delivered during this present year by Mr. Grover Loening at a meeting of the American Institute of Aeronautical Sciences: he pointed out that within the last ten years the domestic airlines passenger-miles figure had risen from 1000 millions to 8000 millions, with a forecast that it would probably rise to 20,000 millions by 1960, and that the airlines should then be free from having to rely on their air mail revenue to balance their accounts. It is true that a question which has never yet been satisfactorily solved is when precisely air mail payments are camouflaged subsidies and when they are not. But if financial solvency can be reached without them, this question can hardly be said to press.

Literature

Metallurgical Thermochemistry. By O. KUBASCHEWSKI and E. Ll. EVANS. London: Butterworth-Springer, Ltd., Bell Yard, Temple Bar, W.C.2. Price 35s.

GREAT progress has been made in recent years, both in the determination of thermochemical data for metallurgical materials and in the application of thermodynamical considerations to metallurgical reactions. Substantial advances are reflected in the Faraday Society's Symposium on "The Physical Chemistry of Process Metallurgy," and special mention may be made of the work of B.I.S.R.A. and the very extensive researches of the U.S. Bureau of Mines. Dr. Kubaschewski, now at the N.P.L., himself a well-known worker in this field and joint author with the late Dr. Weibke of "Thermochemie der Legierungen," has collaborated with another member of the N.P.L. staff, Mr. E. Ll. Evans, to produce a book in which the present position of metallurgical thermodynamics is adequately portrayed. The reader is warned that the term "thermochemistry" in the title is to be understood in the sense of "chemical thermodynamics" because "heats of reaction are no longer studied in isolation from other thermodynamic functions." The authors thus utilise part of the subject to imply a consideration of the whole, an example of synecdoche which is not likely to be understood by those who have not read the preface. The book is in fact a comprehensive review of metallurgical thermodynamics. It is divided into five sections. The first three deal respectively with the theoretical basis of chemical thermodynamics, experimental methods employed in thermochemistry and the estimation of thermochemical data when direct experimental determinations are not available. The fourth section contains 100 pages of tables giving detailed thermochemical and thermodynamical data for a large number of elements and compounds, metallic solutions and metallurgical reactions, with the estimated accuracy of all tabulated values of heat capacities and free energies of reaction. These tables, complete with references to the work from which they were derived, are of outstanding importance as a source of information and they are followed in the fifth section by some examples of thermodynamical treatment of metallurgical problems which offer guidance in the methods of use of the data provided. The book, as a whole, with its logical development of the subject and its excellent compilation of data, will prove to be of value to several classes of reader. Besides being a reliable work of reference for research workers and process metallurgists already expert in the subject, it will help students and others who are acquainted with the elements of general thermodynamics to master a branch of study which is likely to become increasingly important in the development of metallurgical industry.

The Thermal Testing of Steam Boilers. By LESLIE S. BROWN. London: Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, W.C.2. Price 18s. 6d.

As long ago as 1927 the Heat Engines Trials Committee, representing all the leading Engineering Institutions under the chairmanship of the late W. H. Patchell, Past-President of the Institution of Mechanical Engineers, formulated a "Standard Code for Tabulating the Results of a Comprehensive Test of a Boiler Plant." This code prescribed all the measurements to be made and the method of drawing up a heat balance from the data obtained. Time has not affected the value of that report, which is apparently unknown to the author of the present book. The elaborate Power Test Code of the A.S.M.E. seems also never to have come under his notice, for he states in his preface that "there appears to be at present no definite Code upon which the engineer can work" in the matter of boiler testing. The desire to meet this supposed need, as well as to provide, under a single cover, all pertinent information about combustion calculations, is the justification for the volume under review. Even so, it is far from being a complete guide to boiler testing. It contains no descriptions or illustrations of any of the instruments necessary, nor does it give any information about calorimetry or the analysis of fuel or gas.

The brief description, with illustrations, of some of the commoner types of boiler, which forms the subject of the first chapter, is not likely to be of much benefit to anyone with sufficient experience to warrant him undertaking the task of boiler testing. It is followed by some general advice on the procedure to be adopted and the remainder of the book, apart from some appendices, is occupied with detailed examples of the calculations required for the preparation of complete heat balances. The case considered at greatest length is that of a large stoker-fired Lancashire boiler, to which about forty-six pages are given. The steam taken by the feed-pump and by the jets

under the grates are separately included in the list of test results, but no indication is given anywhere as to how these quantities were, or might be, obtained. Indeed, as the recorded consumption of the jets works out to only 2·2 per cent of the boiler output, one is tempted to suspect that the figure was more an optimistic guess than a measurement. In calculating the boiler efficiency the steam used by the jets and the pump is ignored, though in the heat balance sheet the trivial amount of heat required to superheat the jet steam to the flue gas temperature is entered as a loss. To obtain data for calculating the losses by radiation and convection, which are usually estimated "by difference," it is recommended that the average temperature of the exposed brickwork and boiler surfaces should be measured by a pyrometer and the air-currents over them by an anemometer, a procedure which seems impracticable in a boiler-house, even if anything approaching accuracy were obtainable thereby. An attempt is made to compute the heat loss through the foundations of the boiler by an empirical formula, which leads to the unlikely conclusion that the foundation losses of the boiler concerned exceeded the combined radiation and convection losses by more than 50 per cent.

Other boilers of which the test results are analysed are an "Economic" boiler, a water-tube boiler and a boiler of the locomotive type, fired, respectively, with oil-fuel, coke-oven gas and wood refuse. Six appendices contain tables, data and charts relating to the subject of the book. In one of the appendices it is asserted that water vapour in the flue gases exists in the state of dry saturated steam, though, fortunately, none of the calculations in the book appears to suffer from so extraordinary an error.

The Elements of Soil Mechanics in Theory and Practice. By K. H. NASH. London: Constable and Co., Ltd., 10, Orange Street, W.C.2. Price 9s.

IN attempting to compress within four lectures and a hundred pages the elements of soil mechanics, Mr. Nash has set himself a difficult task. The result, however, is a well-balanced and surprisingly comprehensive introduction to the subject. In view of the extensive literature on soil mechanics, the new student is often at a loss to know where to start. The available textbooks present the subject in some detail with a great deal of emphasis on the mathematical and more complicated aspects of the science. The result is that it is difficult to see the subject in broad outline and to appreciate the main problems and their solution without a great deal of reading. Mr. Nash has written a readable book, which presents clearly the methods used and gives useful references for those who wish to study further. As is inevitable with such limited space, some of the sections have been considerably simplified, but he has indicated where the problems are still complex and controversial. Apart from those readers who are particularly concerned with soil as an engineering material, the book should also appeal to the non-specialist who is anxious to keep abreast of current developments in applied science without being confused by a mass of detail.

SHORT NOTICES

Capacitors for Industry. By W. C. Bloomquist, C. R. Craig, R. M. Partington and R. C. Wilson. New York: John Wiley and Sons, Inc. London: Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 36s.—Industrial plant engineers and others responsible for plant installations—practical men who are in search of quick solutions—should welcome the fact that the information in this book is presented in a readily usable style. Much of the data is set out in tabular or graphical form, so that, in most cases, the reader can obtain a numerical answer directly without having to use complex algebra or even to solve a right-angle triangle. The book is based on the physical concept of power factor, expressed as the ratio of useful power (kW) to apparent power (kVA). Among the topics dealt with in the book are the fundamental ideas of power factor, instruments and measurements for power factor studies, the location of capacitors, voltage improvement, the application of capacitors to motors and generators, automatic control, series capacitors, operating characteristics, and installation and maintenance.

Fractional Horsepower Motors. By Stuart F. Philpott, M.I.E.E., F.B.H.I. London: Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 30s.—With the aim of meeting the needs of the makers of small motors and motor-driven appliances, the author of this book has tried to make the subject matter representative, as far as possible, of British practice in fractional horsepower motors. The book describes the principles, operating characteristics, construction, application and maintenance of each of the many kinds of f.h.p. motors used in industry. The treatment of the subject takes the form of a short introductory chapter, followed by nine chapters devoted, respectively, to practical consideration of the various kinds of motors—direct current, universal, polyphase induction, single-phase induction, shaded pole, split phase, capacitor, repulsion and repulsion start, and synchronous motors. Throughout the text the author has avoided going more deeply into motor theory than is needed to understand the working principles. Since the mechanical parts, such as bearings, frames and fixing arrangements, are largely common to all f.h.p. motors the subject of motor construction is dealt with in a single chapter. Motor characteristics, and their influence on the choice of the best motor for a given application, form the subject of the next two chapters. There is a separate chapter on testing, which should be of interest to manufacturers, repairers and users. The book concludes with some useful information on radio interference suppression, which is a matter of growing importance.

Transformers: Their Principles and Design for Light Electrical Engineers. By F. C. Connelly, Ph.D., A.M.I.E.E., A.R.C.S., D.I.C. London: Sir Isaac Pitman and Sons, Ltd., Parker Street, Kingsway, W.C.2. Price 35s.—This book is written mainly for laboratory workers, designers and users of transformers in the light electrical industries, which embrace a diversity of interests, such as line and radio communication, radio-frequency heating, portable machine tools, electro-medical equipment and illumination. It brings together in a single volume information which has hitherto been available diffused throughout a variety of publications.

The first few chapters of the book are devoted to basic principles, and the author's approach to the subject illustrates the difference required in the treatment of small and large transformers. For example, because the influence of magnetising current on design is more important in small transformers than in large ones, he introduces this topic early in the book. On the other hand, he defers the subject of leakage reactance until a later stage, on the ground that, although it may be an important factor in the study of large transformers, it has a much smaller effect, under normal conditions, upon the design of small 50 c/s power transformers. From the more familiar basis of power transformers the author proceeds to a study of the more specialised audio-frequency and inter-valve coupling transformers. The whole subject is methodically treated, with a smooth transition from first principles to design details.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

STANDARDISED SCREW THREADS

SIR,—There are persistent rumours that manufacturers making automobile parts are already going over to American thread sizes and shapes, but nothing authoritative appears to be published. It seems likely that this will apply to all types of engineering and it would be very interesting to hear from correspondents who have already found changes taking place.

It would appear that manufacturers are being rather reticent in many cases and this seems likely to cause considerable trouble with replacements. Surely it would be better if some authoritative statement could be made giving a date from which changes would be made in the various fields of engineering. Can any correspondent, as a preliminary, give information as to the various fields in which changes have already taken place or are imminent? This would at least narrow the field to some extent.

R. BARRINGTON BROCK

Townson and Mercer, Ltd.,
Croydon, September 27th.

PRESENT DAY LOCOMOTIVE WORKING

SIR,—Referring to the letter from Mr. K. N. Harris, July 13th issue, I can confirm that the use of a balancing spring for locomotive reversing gear is far from being an innovation.

Some forty years ago my father (of the Civil Engineer's staff of the G.E. Railway) told me that springs had been substituted for balance weights after an accident had been caused by a weight coming adrift and derailing the engine of a passing train. I do not remember the date or place of this accident, but possibly some member of the railway staff (Eastern Section) could give more information—if sufficiently interested.

It is regrettable that readers' letters are ignored by the railway staffs. For example, after the publication of your article dealing with the first standard locomotive of British Railways design you published a letter in which I asked for information on a number of aspects of the design. No reply was forthcoming—is it that the staff's lips are sealed or that it is indifferent to and contemptuous of the interest taken by the travelling public and locomotive enthusiasts?

E. B. PARKER

Liverpool, September 1st.

BOOKS RECEIVED

Structure and Mechanical Properties of Metals, Volume 2. By Bruce Chalmers. London: Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 18s.

Winding Alternating Current Machines. By Michael Liwschitz-Garik. London: Macmillan and Co., Ltd., St. Martin's Street, W.C.2. Price 63s.

Structural Theory. Fourth edition. By Hale Sutherland and Harry Lake Bowman. London: Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 40s.

Mechanical Engineering Laboratory. By Charles W. Messersmith and Cecil F. Warner. London: Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 28s.

Principles of Mechanism. Fourth edition. By F. Dyson. London: Oxford University Press, Amen House, Warwick Square, London, E.C.4. Price 16s.

1951 *Handbook of British Refrigeration Material and Home and Overseas Buyers' Guide.* London: "Modern Refrigeration," Empire House, St. Martin's-le-Grand, E.C.1. Price 20s.

The Electrician Blue Book Electrical Trades Directory, 1951. Sixty-ninth edition. Edited by Stanley G. Rattee. London: Benn Brothers, Ltd., Bouverie House, 154, Fleet Street, E.C.4. Price 42s.

Iron and Steel Institute in Austria

No. II—(*Continued from page 397, September 28th*)

The Erzberg

ON Wednesday, September 12th, a visit which proved to be of unusual interest was paid by all the members of the Institute to the Erzberg, the Styrian ore mountain. The appearance of this mountain changes year by year through the effect of working, and the photograph we reproduce in Fig. 4 was certainly taken some years ago. It gives, however, a fine impression of what is, in fact, a very impressive sight. It is not literally true to write that the mountain is made of ore. It is not. But some 20 per cent of it consists of ore and that material is exceptionally pure magnaniferous ore that is easily reduced. It is not surprising to learn, then, since it can be so easily mined and is simple to reduce, that the working of

Fig. 4—The Erzberg

the mountain goes far back into history, long before the Romans came upon the scene. It is not our purpose here, however, to trace the history of the working of the mountain, but to write something of its present state. The whole mountain did not come under single management until 1881, when control began to be exercised by the Oesterreichisch Alpine Montangesellschaft. Underground and open-cast workings, designed to supplement each other to advantage were then extended, and, in particular, the amount of open-cast working was greatly extended by terracing the whole mountain in the manner shown by the illustration. Originally, there were sixty terraces each about 40ft high. As a result of later modification, there are now thirty terraces, each about 80ft high. The ore is mined from the mountain in a variety of ways, by the help of dumping shafts, draft flues, conveyance shafts, ore chutes, self-acting braking planes and braking and winding shafts. Locomotive haulage was introduced in 1895, and electrification of haulage, as well as of other mechanisms was begun in 1911, and has since become very extensive. The ore is finally taken down the valley from the village of Eisenerz, which lies just below the mountain, to Vordernberg, some miles away, by rack railway and thence by ordinary railway. Grading and sorting equipment is in operation on the mountain to separate the ore from other materials, such as limestone. The waste material is being dumped alongside the mountain, so that it is possible to say that many hundreds of years hence, when the mountain has been worked out, a whole new "mountain" will have been built alongside it of waste materials! The ore contains 32 per cent of iron and 2 per cent manganese. The highest annual output attained was 2,834,000 tons of ore in 1940. For 1951 the output is estimated at 2,200,000 tons.

The members of the Iron and Steel Institute and their ladies were transported to the very top of the mountain, first by narrow gauge railway in workmen's trucks, drawn by steam and electric locomotives, and then by rope-hauled inclined truck lifts. By good fortune the weather was fine, warm and clear. At the top they were able to observe a method of removing the top of the mountain that has recently been adopted. In this method, which is illustrated (very diagrammatically) in Fig. 5, one or more vertical shafts are driven from the mountain top into horizontal shafts on a level with the topmost terrace. The tops of the vertical shafts are opened out into funnels, the material removed falling through the shafts on to conveyors below which transport it on to the terrace or deliver it into vertical dumping shafts. From the lip of a funnel, or "glory hole" as it is termed in America, where the method originated, the observer looks down into something reminiscent of the mouth of a volcano. As the "glory hole" is opened out and driven downwards, the whole of the mountain top is removed. From the top, the members walked down on to the first terrace. Here, as indicated in the diagram, an excavator was operating to pick up rock removed from the face by blasting, and place it in a lorry. The latter took the material to a dumping shaft. At present, we learned, the rock, after crushing, is hand-picked to extract the ore down to a size of a centimetre cube or so. But mechanical sorting plant is about to be installed, whilst machine methods have long been used to separate the fines. The party finally descended the mountain by a rope railway to Eisenerz, observing on the way down how the mountain is ringed about with narrow gauge railway lines. The ingenious method of carrying electric overhead lines on curved arms attached to sleepers so that the wires are automatically kept in position whenever the track is moved was noticed. Luncheon was taken—rather late!—at Eisenerz; and just as it concluded, the party was invited outdoors to see blasting carried out on the mountain which overhangs the village.

On the return journey by coach to Leoben, whence the members were to return to Graz by train, we were fortunate to have with us Professor Walzel, Professor of Ferrous Metallurgy and Head of the Ferrous Metallurgical Institute, Montanische Hochschule, Leoben, and the author of a particularly interesting paper published in the August, 1951, *Journal* of the Iron and Steel Institute, entitled "The 2000-Year Tradition of the Austrian Iron and Steel Industry." For our coach made a stop at Vordernberg, which lies about 12 miles north of Leoben and which was at one time so important a centre of the Austrian iron and steel industry that 88 per cent of Styrian iron production was there concentrated. Indeed it was here, and not at Leoben, to which it was later transferred, that in 1833, the Styrian Archduke Johann set up the school of mining and metallurgy which eventually became the Hochschule. Professor Walzel at once proposed that during the few minutes halt available, we should visit an old blast furnace. It turned out to be housed in a three-storey classic-style building, fronting the main square of the village, and dated 1846. This furnace is the best preserved of fourteen such furnaces that once existed in or near Vordernberg. The building, which is now carefully preserved is in good order. The brickwork of the furnace is still there; the wheel of a water lift, by which materials could be lifted to the top of the furnace is in working order; and rails and trucks by which ore was delivered are still to be seen. The power needed was generated by a water wheel. We could, with profit, have spent a longer time on the premises. But, unfortunately, the programme did not permit further delay.

Gratefully, for to date the programme had proved strenuous, the members of the

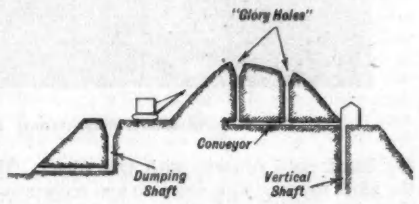


Fig. 5—Method of Working Top of Erzberg

Institute found themselves granted an evening "free in Graz."

Schoeller-Bleckmann

Engineers take many things for granted. That fact was impressed upon us the following day, September 13th, when we chose to attend a visit to the Schoeller-Bleckmann Stahlwerke A.G. at Hönigsberg-Mürzzuschlag, whose works are illustrated in Fig. 6. Engineers are well accustomed to the use of files and rasps. But how many have ever seen them made? And how many have ever paused to consider how they might be made? The Schoeller-Bleckmann concern makes much else besides files and rasps. The manufacture of these tools, indeed, forms quite a minor part of its activity. Yet it is the modern file factory that we saw at these works that sticks most firmly in our memory.

The first process is that of forming the file. The file blanks are forged to shape under high-speed hammers between dies. They are then annealed. Next it is necessary to remove the hard outer skin that has resulted from prior operations. For this purpose large diameter grindstones are used. For flat file blanks a number are mounted upon a flat plate supported between two arms hinged near floor level. The plate is pressed against the periphery of the wheel by the use of hand levers at the tips of the arms, and the plate is simultaneously and automatically traversed downwards. This method of grinding, it will be noticed, compensates for the slight taper of flat files and ensures that the whole of their faces are ground. For round and half-round files a different method is employed. The operator sits astride a wooden arm arranged like a

hobby-horse, hinged at the rear of the operator and carrying a counterweight at its rear end. The upper end of the arm projects over the periphery of the wheel and carries a metal fixture between which and the wheel the file blanks can be inserted. A simple winding attachment is placed on the hasp of the file. Then by placing a file blank under the fixture and letting his weight act upon the arm through the saddle over which he stands, the operator can bring the blank into contact with the wheel. If the file is round simple rotation and reciprocation of the file blank by means of the winding attachment will ensure all its surface is ground. If it is half-round the blank is rocked from side to side.

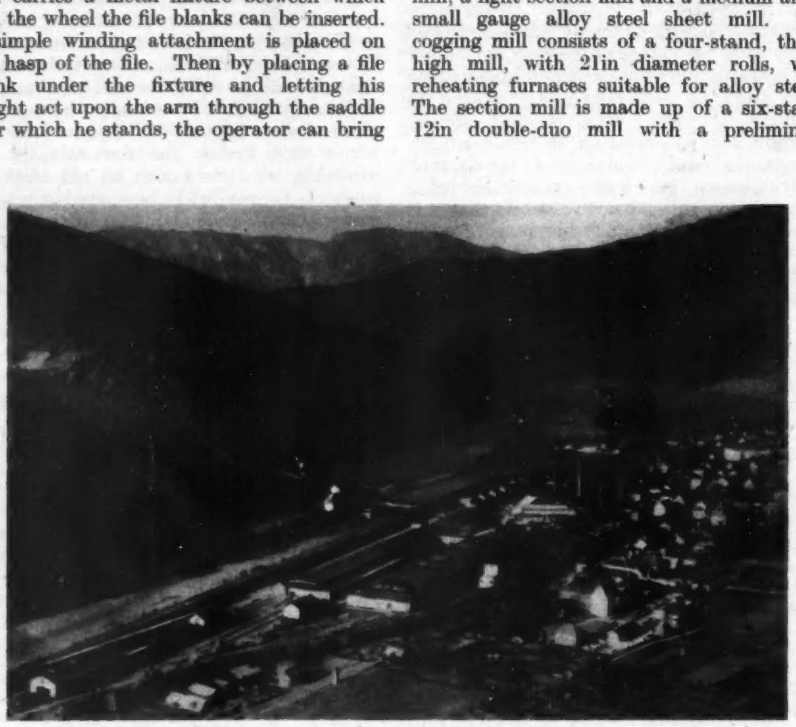


FIG. 6—SCHOELLER-BLECKMANN AKTIENGESELLSCHAFT STEEL WORKS

The blanks next go to the chiselling machines. Each is mounted on the table of the machine. A chisel (or chisels) reciprocating at high speed form the file, each blow creating a tooth, whilst the table traverses across beneath the chisel head. In the making of rasps a somewhat different action is observed. The cutter is mounted at the end of a head whose form and whose action is that of a miniature hand pick. At each stroke a tooth of the rasp is lifted out of the parent metal. Here the machine table is arranged to traverse sideways until a row of such teeth has been formed and then to move one step lengthways in readiness for the next row to be formed. The chisels in these machines can be set at any desired angle, and for the smaller files the action is very rapid. We estimated it to reach some five to ten strokes per second. High-speed steel is the material used for the chisels.

Next follows the process of hardening. In order to prevent overheating of the tips of the file teeth the files are brought up to temperature in salt baths. The final operation before packing is the scrubbing and washing of the files. The monthly output of the file factory reaches some 250,000 files, and the products are exported to many parts of Europe.

After visiting the file factory the party went to the rolling mill plant. Extensive re-equipment is being carried out upon this plant and considerable further reorganisation is planned. For, as we have already mentioned in the introduction to these articles, it is intended, under the present reorganisation of the entire Austrian iron and steel industry, to concentrate here most of the Austrian alloy steel sheet production. The firm will, too, continue to produce a wide range of alloy steel bars, rods, forgings, &c. At present, the mills consists of a cogging mill, a light section mill and a medium and a small gauge alloy steel sheet mill. The cogging mill consists of a four-stand, three-high mill, with 21in diameter rolls, with reheating furnaces suitable for alloy steels. The section mill is made up of a six-stand, 12in double-duo mill with a preliminary roughing stand and a seven-stand, 10in double-duo mill with two 13in, three-high roughing stands. As the party was able to observe much of this plant is obsolescent and, indeed, it is intended to rebuild the mills. Sheets are hot rolled in three mills, each containing three three-high stands capable of rolling sheets up to a maximum width of 52in. Stainless sheets are cold rolled in one three-high and one two-high cold mill. The output capacity here is about 800 tons a month. A new sheet mill building is under erection, but the mill is still to be installed.

In going round the works the party was taken into one very large and almost empty shop. This shop was constructed during the war for the construction of turrets for armoured vehicles. It was dismantled by the occupying powers after the war. It is now used to a slight extent as a store, and in one of its bays grinding, linishing and finishing plant for stainless steel sheet has been installed.

During the evening of this day there was no engagement. Most of the members, in fact, were engaged in packing luggage for transport to Pörtschach next day.

KLAGENFURT AND FERLACH

On the following day members left Graz for Pörtschach by coach. A stop was made on the way for some refreshment at Voitsburg, and there was time to view, but not to go round, the open-cast and underground coal mines there from which mainly lignite, but some bituminous, coal is obtained. Lunch was taken at Klagenfurt, in the Landhauskeller, the walls of which are almost wholly covered by painted shields bearing the arms of those who, in the past, served upon what might be termed the State Council of Carinthia.

After lunch we took part in a visit to the Kärntnerische Eisen-und Stahlwerke A.G. and the Guild of Gunmakers (Genossenschaft der Buchsenmacher) at Ferlach, not far from the southern border between Austria and Yugo-Slavia. The first-named firm produces wire and various products of wire such as nails, mattress springs and barbed wire, and there is a modern workshop for the making of gauges and tools. There is no need here to refer further to the rod-rolling and wire-drawing equipment which, though well arranged, had little that was novel to show. But again, as at the Schoeller-Bleckmann works, it was impressed upon us how much we take certain articles in common use for granted. How many people know how nails are made? Actually, they are made in just the fashion that any one who examined such a nail would expect. The wire from a bobbin is fed into a die head leaving a short length projecting. A single blow from a hammer block upsets this material to form the head. The wire is then fed forward the length of a nail and cutters part it off, forming the point as they do so. On the smaller, faster running machines, nails were being produced at a rate of several hundreds per minute. The resulting nails are visually inspected while travelling along a belt, any that are faulty being rejected. For the packing of the nails into the paper cartons with which everyone is familiar, a magnetic machine was in use. This machine has two flat plates whose parallel faces are placed a distance apart about equal to the length of the nails to be packed. A shaking chute delivers nails from a hopper to the space between the plates. The plates, being magnetised, one as the north and the other as the south pole of a magnetic system, the nails align themselves across the space. As all the nails are now in parallel (though heads may be one way or the other indifferently) they can simply be swept out by hand or by a suitable tool straight into a carton. Subsequent weighing and the addition or subtraction of a nail or two ensures that the packet contains the correct number of nails.

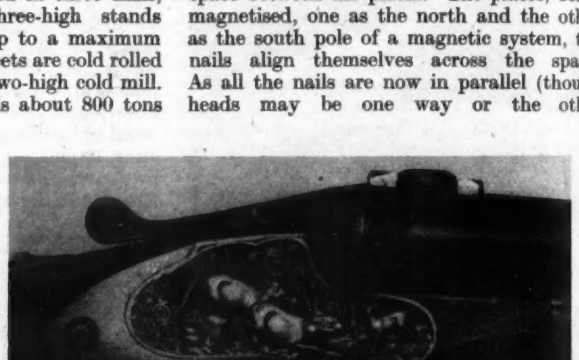


FIG. 7—ENGRAVING ON GUN

Another interesting job observed here was the making of mattress springs. Such coil springs, it will be remembered, are of greater diameter at the ends than in the middle. This form is very simply produced. Wire from a bobbin is fed through a die and over a tilted roller against a cam-shaped

"former" which causes it to bend. As the wire feeds through, the "former" moves inwards towards the roller and then outwards again, thus reducing and then increasing the radius of the bend, whilst the tilt of the roller ensures that a helix will be formed. Knives cut off the wire, of course, at the end of each cycle of operations.

A barbed wire making machine was specially slowed down so that the visitors could see how the "barb" was twisted on and cut and the body wires twisted to hold it in place.

Another interesting product seen under manufacture was twisted square steel rod for reinforced concrete. A carriage carrying the operator runs upon rails between two fixed heads some 20 yards apart or more. Rod is fed through a fixed head from the coil by hand. The carriage advances and the end is gripped in a rotary chuck in its face. Next the carriage retires to the end of its travel. The rotating chuck is then operated to give a predetermined number of turns and the rod is then released from the carriage and cut near the fixed head, the finished twisted rod being rolled aside. Meanwhile, all has been made ready at the far fixed head and as the carriage returns down the way it draws with it another rod from that end.

At this works a simple method was adopted for keeping separate the parties into which the group of members visiting the works was divided. Small boys acted as "standard bearers" carrying upon wooden poles cards lettered "A," "B," &c., planting themselves close to the guide whenever he stopped and following him closely whenever he moved. The results were very effective.

Gun-Making

There followed a visit of quite unusual interest. In few countries does cottage industry still flourish. But here at Ferlach, helped, in appears, in several ways by the firm about which we have just written, there exists a Guild of Gunmakers making sporting guns and rifles of particularly fine quality. Some of the work is done in central workshops, some in the homes of the cottagers. The essential metal parts are rough assembled in central workshops containing a drop forge hammer, &c., and there are machine shops for boring and annealing and grinding equipment. Guns are tested in a proving house by means of a Government-specified overcharge, and a testing ground is available for final firing trials. If satisfactory results are shown—we imagine having seen the high quality of the workmanship that it is seldom they are not!—a Government stamp is impressed on the gun. Much of the work is done by hand and we were privileged to see some of the men at work. Many of the guns are specially engraved with designs that are worked freehand in the metal. That work—the illustration, Fig. 7, shows a particularly fine example—is done, as we were able to observe, with quite astonishing sureness of touch in use of the tools and with remarkable speed. No standard range of guns is made. Indeed, since so much hard work is involved, the making of guns to customers' special requirements, in which the Guild takes particular pride, takes little longer than would the making of more standardised articles. Surprisingly enough, we learned, upon inquiry, that these beautiful hand-made weapons are by no means expensive to buy.

The members of the Institute were so entranced at looking at this work and in examining the finished products, that it was with difficulty that they could be got away.

Portschach

Pörtschach, situated upon the banks of a fine mountain-surrounded lake, is a charming holiday centre. That point, however, was not immediately appreciated by members arriving at dusk and after night had fallen. For, though according to programme nearly everyone was to be accommodated at a single large hotel, in fact it was found upon arrival that the members were to be distributed singly and in groups amongst numerous hotels. This alteration so complicated the problem of transporting and distributing what amounted to some 6 tons of luggage (that had been carried independently by lorry from Graz), that many members did not receive their bags until quite late in the evening. All we need say further upon that score is that the Iron and Steel Institute and its staff were not a whit to blame. It may, however, have accounted for the fact that there were some absentees from a reception at the Park Hotel, given that night by Landeshauptmann F. Wedenig, Governor of the State of Corinthia.

(To be continued)

A Lubricants Plant

ON September 25th, at the invitation of Shell-Mex and B.P., Ltd., we attended the opening by Sir Frederick J. West, G.B.E., of the extension of the company's lubricants plant at Barton, Trafford Park, Manchester. The principal components of the factory area consist of a new plant for the blending, packaging and dispatch of lubricating oils, including facilities for bulk loading of road tankers and railcars; a plant for preparing and reconditioning of packages; a plant for the manufacturing, packaging and dispatch of greases and a building housing a laboratory and administrative offices. The guests were welcomed by Mr. C. M. Vignoles, O.B.E., the managing director of Shell-Mex and B.P., Ltd., who said that it was particularly appropriate for Sir Frederick to perform the opening ceremony in view of his association with the Manchester Ship Canal and the dependence of the Barton plant upon that waterway for both the supply of raw materials and delivery of the finished products. Mr. Vignoles referred to the increased demand for petroleum products and mentioned that the increase for lubricating oils and greases had been from 560,000 tons to 800,000 tons. After the official opening ceremony the guests made a tour of the plant and later saw a showing of the new film entitled "Grease," which demonstrates the manufacture of grease in the laboratory and then the methods and machines used for bulk production.

Description of New Plant

The reconstructed Barton lubricants plant, which was designed by the Shell-Mex and B.P., Ltd., is understood to be the only vertical plant producing lubricating oils in the country. The premises occupied by the company are divided into two by the main road, the south site being a tank farm, having a capacity of some 21 million gallons, together with constructional and maintenance shops. A grease plant and the new plant are contained in the north site, which lies on the bank of the Manchester Ship Canal. There is a jetty from which oil, warmed in the cargo oil tanks of the tanker, is pumped through 8in diameter overhead pipe-lines to the tank farm. Steam heating coils in the main storage tanks are employed to ensure a viscosity at which the oil can be readily pumped. The oil, which is the basic stock used in the manufacture of lubricating oils and greases, comes from refineries such as those at Stanlow, Shellhaven, Curacoa and Pernis.

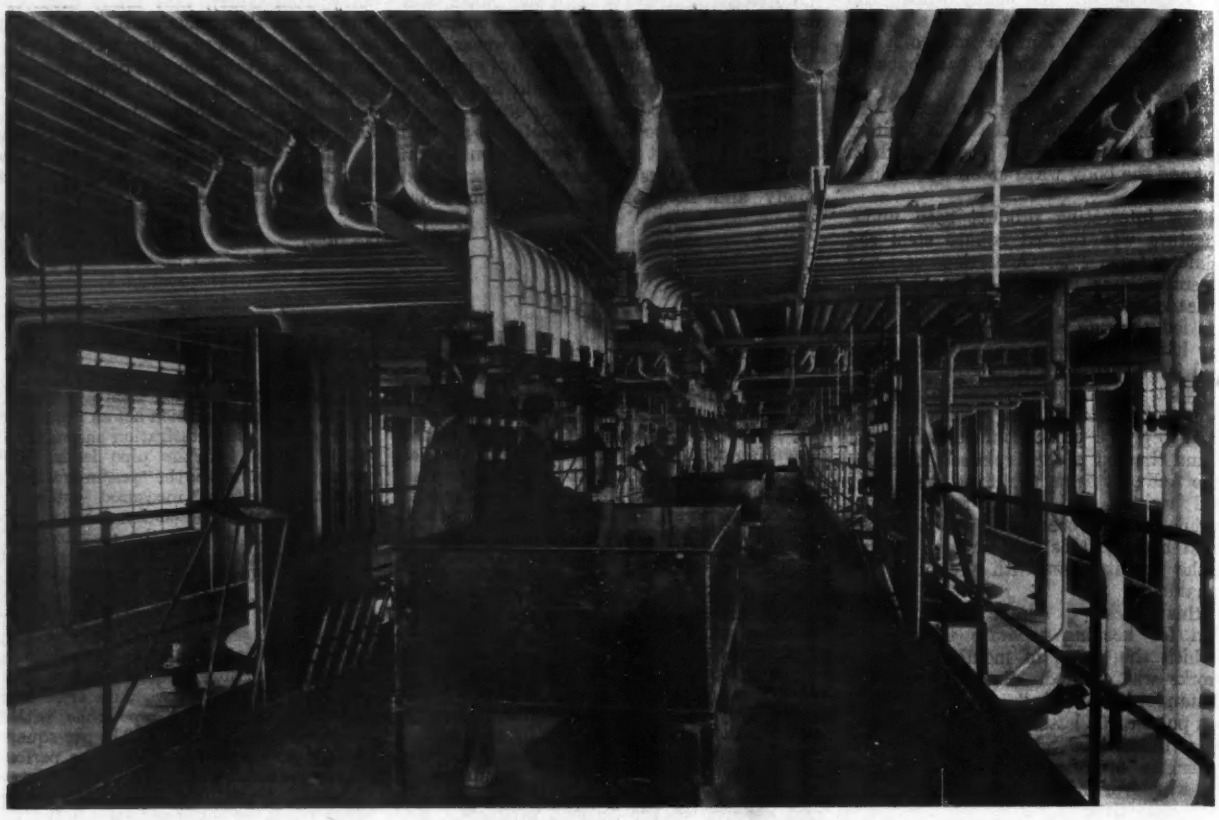
The lubricants plant, as already mentioned, operates on the vertical system and the stock is delivered from the tank farm, by means of steam pumps, to a distribution point at ground level. From here five horizontal duplex steam pumps, each having a capacity of about 60 tons per hour, raise the oil through a height of approximately 80ft to fill the 50-ton capacity storage tanks. The tanks, some of which are subdivided, are twenty in number and approximately 30ft long by 9ft diameter and have steam heating coils to maintain the oil at the right viscosity. The tanks, which are interconnected, each contain a different component oil, and pipes from each tank are led to open distribution boxes, which act as funnels, on the floor below. Our illustration shows the distribution boxes and the pipe leads from the storage tanks and also the "pneumercator" gauge panels. Carefully measured quantities of basic oil stock are fed by gravity from the storage tanks through the distribution boxes (each serving six blending kettles) to a battery of 20-ton capacity totally enclosed blending kettles, of which there are sixteen. The blending kettles, seen in our illustration, are calibrated and "pneumercator" gauges indicate the quantities in pounds so that the amount of each constituent required for a particular blend can be checked within a close degree of accuracy. Perforated pipe coils within the kettle carry air at about 10 lb per square inch and the air escaping through the perforations creates turbulence and ensures that the oils are thoroughly mixed. Steam heating coils are also fitted within the kettle and assist in the blending by raising the temperature and reducing viscosity. Gauge boards on the control platform mount temperature indicators, the normal range of temperature being from 60 deg. Fah. to 140 deg. Fah., depending upon the specification of the oil.

The various fats required for the lubricating oil production are delivered in barrels at ground floor level, where an infra-red heating muffle is dropped into each barrel to melt the fat. The melted fat drops into a tank, heated by steam coils, from which it is pumped to the distribution boxes by horizontal duplex steam pumps of 30 tons per hour capacity through a head of approximately 50ft. Certain turbine oils and those which require final polishing have earth and lime added to them in the blending kettle and afterwards the oil is passed through filter presses by pumps which have a capacity of about 40 tons per hour against a pressure of 75 lb per square inch. In addition to the 20-ton blending kettles, there are two of 5-ton capacity, which are connected to the road wagon filling station only. The road wagons generally have a capacity of 5 tons and the small-size kettles are used to provide a small quantity of a particular lubricating oil rather than call upon one of the 20-ton models.

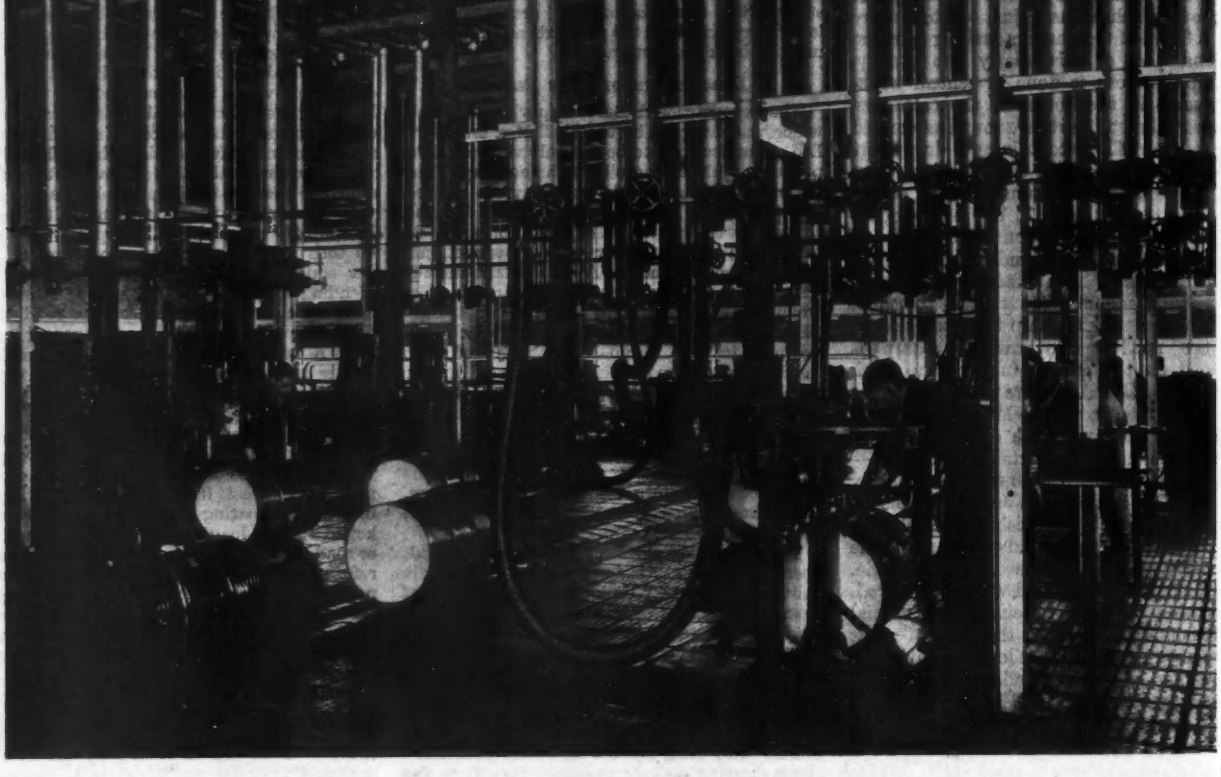
Below each blending kettle is a battery of pipe connections, together with the appropriate valves and this system of multi-connections makes for great flexibility in supplying the blended lubricating oil from any one blending kettle to any loading point for rail tank cars or road tankers or to the service tanks. Another refinement fitted to the filling lines is an air connection, which is provided for blowing air through the pipes to clear them of oil completely, so that the next blend of oil to pass through the pipes will not be contaminated. Barrels and drums are filled from the sixteen two-compartment service tanks, but by-pass arrangements are also provided.

The small package filling room has empty drums, which are delivered by an overhead conveyor from the empty package preparation shed, at one end, and filled drums stacked in pallets at the other. At mid point in the length

BARTON LUBRICANTS PLANT OF SHELL-MEX AND B.P. LTD.



DISTRIBUTION BOXES



FILLING POINT

of the room are electrically operated filling machines, which are supplied from three 10-ton tanks overhead and can fill 150 5-gallon drums or 500 1-pint containers per hour. For filling, a lever is depressed to open the valves and when the drum, which is standing upon a scale, is full an electrical contact is made and the valve is closed. The 1-pint containers, which are truncated cones, are sealed in a special machine.

The barrel filling station, illustrated herewith, is at ground level and the barrels are delivered from the package preparation room by overhead conveyor to the filling machines, which have automatic electric weight control. Forty separate lines, each carrying a different grade of oil, are duplicated to the filling points on the eight machines, and, when full, the 40-gallon barrels are rolled on to a conveyor at floor level and transported to the warehouse and the road and rail loading points. In the road tanker filling bay the road vehicles are automatically weighed before passing to the filling point, set below an overhead gantry, which carries the filling pipe-line, and then weighed again when full.

The Film "Grease"

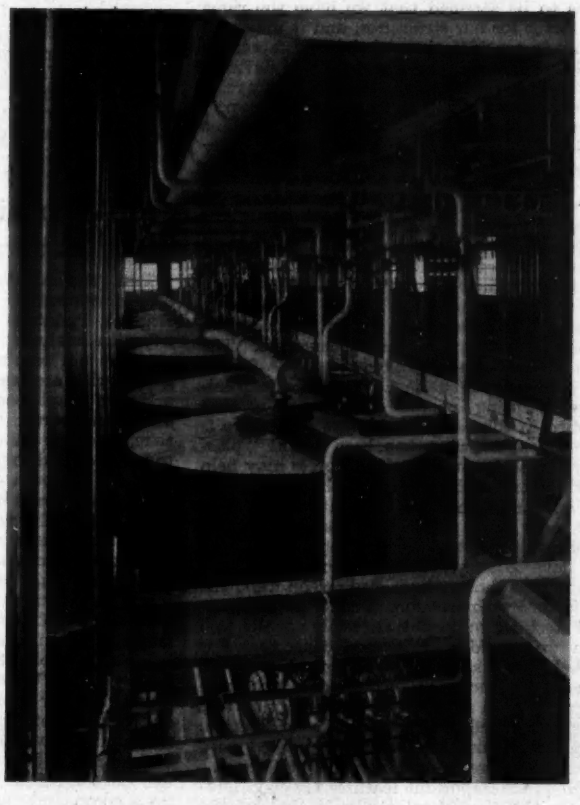
The film which described the manufacture of grease, concentrated on ball and roller bearings as examples of the use of grease as a lubricant and the opening sequences reviewed the production of ball bearings. Small balls were made from high-quality wire, which was fed to a "ball header," where the rough shape was stamped out. This was followed by a number of operations in a series of machines, "flash" was removed by filing, and then came the rough and final grinding of the balls, which were still soft. At this stage they were hardened and then passed through a "lapping" operation followed by "tumbling," first in rouge and then in caustic soda, and then they were cleaned by "tumbling" with chamois leather.

Grease production by laboratory methods formed the second part of the film. The first step was to make soap concentrate in oil by using a fatty material, some lubricating oil and an alkali, such as the hydroxides of lithium, barium, aluminium, calcium or sodium. In the example shown sodium hydroxide was used to produce a sample of sodium base grease. The different characteristics of greases produced by using different alkalies were demonstrated. Sodium base grease dissolved in boiling water, whereas calcium base grease was hardly affected, while under conditions of dry heat the position was reversed. In appearance the sodium base grease was fibrous and spongy and the calcium base product was smooth, polished and buttery. Other examples included greases with additives such as graphite, wool yarn and rubber latex, representing the incorporation of a polymer.

Before commencing bulk production many operating tests are carried out and the film showed the mechanical work which tests the ability to maintain consistency under working conditions; the "bomb" oxidation test to measure resistance to oxidation; a rig for measuring heat generated in a high-speed bearing; and a heavy load rolling test machine.

Finally, the film dealt with the bulk production of grease. The materials are stored in bulk, the tanks are heated by low-pressure steam coils to prevent solidification, and the ingredients are pumped through pipe-lines, which are steam traced and lagged, to the top floor of the manufacturing building. The delivery lines for oils, fats, fatty acids, bitumen are connected by headers to measuring tanks which are fitted with telegauges, connected to indicators mounted on a panel, which enable the operator to exercise precise control over the quantity of each ingredient.

In the film a quantity of fatty acid was measured first, followed by about 60 per cent of the total amount of lubricating oil required, and then the alkali, sodium hydroxide, which was dissolved in its own weight of water. The purpose of the water was to cause certain chemical actions between the alkali and the fatty material, when the mixture is heated, to form soap. All the ingredients were passed through strainers into an autoclave of 5 tons capacity, which is heated by circulating hot oil around the jacket. The camera gave an internal view of the pressure vessel and showed the electrically-driven planetary paddle gear in operation. The temperature rose, the water turned to steam to create an internal pressure of about 50 lb per square inch, and saponification was complete when the temperature had risen to a figure of 140 deg. Cent.



Blending Kettles

At this point the valve at the bottom of the autoclave was opened and the soap was forced out under the pressure of its own steam into a 5-ton mixing kettle, which could be heated by high-pressure steam or cooled by water. A planetary paddle gear stirred the mixture to the correct consistency and then it was cooled down at a controlled rate. After checking a sample to ensure that the balance between acidity and alkalinity was correct the remaining 40 per cent of the oil was stirred in. Another test was made in a penetrometer to assess the consistency of the grease. This was done by measuring the distance which a cone penetrates the surface within a fixed period of time. The base of the mixing kettle extends through the floor to the package department, and here the grease was pumped through a fine-mesh strainer into kegs, where, after maturing for twenty-four hours, it was subjected again to the penetration test and samples were taken for laboratory tests. The alkalinity was tested by dissolving the grease in petroleum spirit and adding hydrochloric acid; then, by titration, the quantity of caustic soda needed to neutralise the mixture was ascertained. The water content was checked by distilling a sample of the grease dissolved in spirit and the drop point determined.

The film showed many examples of the use of grease and referred to the "Comet," which required a grease with a satisfactory performance at a ground temperature of 120 deg. Fah. and below zero temperatures at 40,000ft. A lithium base grease was produced which tests showed would satisfy these requirements. For bulk production a new plant, known as the continuous closed method, was devised, consisting of a tubular heater formed of three concentric pipes, the inner and outer pipes carrying hot oil. The slurry was quickly heated as it was pumped through the annular space between the inner and outer pipes. Rapid cooling was essential to prevent oxidation, so the heater discharged the molten grease on to a stainless steel conveyor band floating on cold water to form a layer of grease ¼in thick.

Grease Plant

The grease plant at Barton consists of two measuring tanks serving each autoclave, around which hot oil circulates at approximately 270 deg. Cent., and this in turn flash discharges into two mixing kettles, which are heated by steam at 80 lb per square inch and are cooled by water. The anhydrous mass in the kettle slowly cools to about 95 deg. Cent., when the grease is formed and the balance of the mineral oil is added, plus a dye. A penetrometer was on view and this measured the penetration of the cone in units of one-tenth of a millimetre. The time allowed for penetration is five seconds and the reading must be within ±5 per cent of a given figure.

In the production of aluminium stearate greases static cooling is required, otherwise the material it will deteriorate into a mush, and also rapid cooling in order to maintain consistency. For the latter requirement a chilling and milling unit is used and consists of two sets of water-cooled rollers placed one above the other. Grease from the mixing kettle is pumped into side hoppers and passes as a thin film over the upper rollers, where it is homogeneously cooled down at a steady rate from 140 deg. to 40 deg. Cent. Scrapers remove the grease film which falls into hoppers, where it ages before passing through the spring-loaded water-cooled milling rolls, from which it is scraped ready to flow into packages.

The continuous closed method for the production of lithium base grease was inspected. In this a slurry of lithium stearate in oil passes through the tubular heater, where its temperature is raised from 20 deg. to 220 deg. Cent., and it is then fed through a dispenser on to the water-cooled stainless steel belt travelling at about 20ft per minute. After 30ft of travel the layer of grease, ¼in thick, is scraped off. The grease is homogenised and passed through screens and a filter. Prepared in this way, the lithium base greases have a melting point of approximately 190 deg. Cent., and can function at a temperature approaching 55 deg. Cent.

Building Research in Canada.—We have received from the Division of Building Research of the National Research Council of Canada a publication entitled "Building Research in Canada: A Progress Report," which outlines the work done in this subject since the formation of the Division of Building Research in the autumn of 1947. It is expected that a second progress report will be published in December, and subsequently reports will be published each quarter. An overall account of the work and achievements of the Division is given, with a list of its publications. A climatologist has recently been appointed to the Division, since the Canadian climate is one of the main factors which make building practice in that country rather different from elsewhere.

Symposium on Prestressed Concrete

ON September 24th and 25th last, the Prestressed Concrete Development Group of the Cement and Concrete Association held a symposium at the Institution of Civil Engineers entitled "Prestressed Concrete Statically Indeterminate Structures." Seven papers on this subject were presented and discussed, and at the final meeting Dr. F. G. Thomas, of the Building Research Station, summarised the papers and discussion. We give below an abstract of the address delivered by Dr. Thomas.

A wide range of statically indeterminate structures has been considered in our discussion. I shall try to sum up what we have learnt about them in the last two days, and perhaps more important, what should be the course of our future study in order that we may design them more efficiently and economically. As a research worker I shall start with the experimental work. Only a part of one paper described experimental work, but reference has been made to other work in several papers. Experimental work is vital if there is to be progress in any new field. Although one can build structures, and they may stay up, one cannot know for certain what the margin of safety really is; the way to economy is to develop the experimental work in order to determine the parameters that have to be introduced into the design theory, and to develop the theoretical analysis so that engineers can understand it.

There has been much "friction" at this symposium, particularly in terms of cap cables, where the friction is accompanied by another apparent defect—the slip in the anchorages. Apart from the practical difficulties that have been mentioned with regard to cap cables, it is quite evident from the discussion that we want to know quite a lot more about the friction developed with such cables—or, indeed, with any cables in which there is curvature. We have, in fact, been told that even in straight cables there may be appreciable friction. There does not seem to be complete agreement with this, and we certainly want to know more about it. It is quite clear that we ought to find out more about the coefficient of friction for a wide variety of conditions—different types of wires with various surface conditions, working in different types of sheathing or holes in concrete. Secondly, there should be research or development work designed to reduce the value of the coefficient of friction, by suitable sheathing or other means. It has been suggested that these difficulties can be overcome by avoiding the curvature that induces friction losses; but again it has been pointed out that to work on such lines is to lose the desirable flexibility of such structural systems. In many cases it is a great advantage to use curved cables, but much of this advantage may be lost unless this friction loss is kept to a minimum. If we have the data—the coefficient of friction and the losses at anchorages—then we can make the necessary allowance. This kind of data can be obtained from tests in the laboratory and occasionally on full-scale structures, and must be obtained in order to obtain more economical designs.

There has been quite a lot of discussion about the redistribution of moments in continuous beams, and the general opinion appears to be that at working loads there is not much redistribution—or, alternatively, if there is, it is an advantage. I do not think that point of view has been wholly accepted, and I do not think it is quite in line with the discussion we had on the effect of shortening of members, where it was considered necessary to allow for the effect of the elastic shortening arising from prestressing, and for shrinkage. Creep may be quite as important, and the deformations due to it might be as much as the elastic and shrinkage movement put together, and it seems that this particular point requires further consideration.

We have had practically no direct data concerning ultimate loads, apart from the results of some tests which have been started at London University. However, from what data we have on steel or reinforced concrete structures, and from our knowledge of the deformation characteristics of simply supported prestressed concrete beams, it certainly does appear at this stage—though again further data will be required—that the redistribution before failure is likely to be smaller with prestressed concrete than with ordinary reinforced concrete; and, as was mentioned, the approximations that we are accustomed to make with ordinary reinforced concrete frame design—which to some extent rely upon the ability of ordinary reinforced concrete to accommodate itself to moment conditions for which it was not designed—may not be applicable to prestressed concrete. We may need to be very much more careful about our estimation of the moments throughout continuous frameworks. The same applies to the possibility of differential settlement of foundations or abutments; the effects with prestressed concrete may be more serious than with ordinary reinforced concrete. Again, most of what we have heard about this particular subject is based upon opinion or on some theoretical treatment, but that is not sufficient for us to be satisfied that we have the right load factor for our structures, and it may well be that in considerations of the load factor we should allow more for the possibility of differential settlement than we do with ordinary reinforced concrete. The type of failure of prestressed concrete members has an important bearing on this. A very sudden failure may sometimes occur with prestressed concrete; such a failure is very much rarer with ordinary reinforced concrete. Again, we have not very much information; the ultimate strength and the behaviour at failure of even simply supported prestressed concrete beams is a subject on which we know very little indeed.

With regard to redistribution of stress, it appears that this would be of some value, particularly for lower strength concretes. The point has been made that our factor of safety or load factor should take account of the possibility of using poorer concrete than that assumed in the design; the fact that there is more creep, or what has been called "plasticity," with lower strength concrete may help to reduce the loss in strength of the structure.

It appears to me that the contribution from those who have discussed theory has been mainly to indicate the changing assumptions that have to be made in our calculations; the assumptions that we have made when using the elastic theory for reinforced concrete or structural steel design do not all apply equally well when we consider prestressed concrete. For example, the shortening of members of a framework is normally neglected in structural design, but in prestressed concrete this and other effects need to be taken into consideration. Once this is done, however, the method used in design is largely one of personal preference.

One of the important features for consideration in the theoretical study is that of the secondary moments, and in this connection variation in cable position has been shown to be of some importance. Contractors on the whole in this country are very good, but nevertheless it is difficult, as Professor Evans said, to keep the reinforcement or prestressing element exactly where it is shown on the working drawings, and it was shown in one paper that small variations in the cable position would have an important effect on the secondary moments. The positioning of the cable in design is possible in two primary ways; one is to use the concordant cable about which we heard from M. Guyon, or we can adopt a more or less arbitrary position deduced by previous experience, or intuition, or some rule-of-thumb method such as following the bending moment diagram.

With regard to ultimate load, I must not here enter into what has been called a philosophy of safety; but nevertheless ultimate load has been mentioned several times, and it is quite clear that we know practically nothing about it in connection with prestressed concrete continuous structures. The relationship between stresses and loads has been discussed, and it has been pointed out that to work to certain design stresses may give little or no indication of what margin of safety we have against collapse. Here obviously is a field for study, again particularly experimental.

Another point which has not been agreed upon here is the use of subsidiary non-prestressed reinforcement. Some members have advocated it and said that it was necessary, but others have said that to mix ordinary reinforced concrete and prestressed concrete is impossible, or at any rate illogical. The use of such additional steel may be of value in controlling cracking or in increasing ultimate strength. We have no scientific data for judging the real value for this subsidiary reinforcement.

The final section with which I want to deal is that of practice, and here I need say very little. Although, as I have said, for ultimate economy and full efficiency it is necessary to develop theories and to obtain the parameters of those theories from experiment, progress in prestressed concrete work will in general come from the fact that structures have been built with it.

The practical difficulties of friction of curved cables, of anchorages, particularly for short cables, and expansion joints have all been overcome in important structures; none has yet fallen down, as far as I know. It is likely—as some of our designing friends have agreed—that the load factor in many of these structures is much too high. The reduction of this factor is mainly dependent on further data, particularly experimental data, being obtained.

A Mechanical Vibrator for Laboratory Sieves

THE machine described in this article has been developed by British Railways (Western Region), Paddington, for use in soil size distribution analyses. It is designed to take up to eight 8in or six 12in diameter sieves, together with a cover and bottom collecting pan and is of simple construction, with a minimum of moving parts. The sieves are arranged in tiers, and the material is poured on to the top sieve and agitated mechanically. The machine has been in operation for a year and has proved satisfactory, observation having shown that the whole area of each sieve is being used, the wear of the sieves thus being kept to a minimum.

The sieves are held in a rectangular inner frame of tubular steel, which is suspended between four 6in by 2in diameter helical springs from an outer frame, the tension of the springs being adjustable. Slung underneath the inner frame is a 37V–160W electric motor, of the kind used for concrete vibrators. At each end of the motor shaft an eccentric weight is mounted, the weights being out of phase with each other by 90 deg. The speed of the motor can be controlled. The eccentric weights set up a compound vibration, the result of which is to shake particles of a sample round the sieves in a circular motion.

Tests of the machine indicated that stable conditions are reached after seven or eight minutes and after five minutes' sieving the results obtained differed by an average of only 0·14 per cent from the results obtained after sieving for twenty minutes. To achieve the same results by the usual manual method, it is stated, would require the services of a trained operator for about forty-five minutes.

"TESTS OF STANDARDS OF LENGTH AND ANGLE."—A booklet with the above title has recently been published by the D.S.I.R., giving details of the testing facilities offered by the National Physical Laboratory. The booklet, which is described as "Test Pamphlet (Schedule of Fees) No. 7," gives the Laboratory's conditions for testing various sorts of gauges and length bars.

Pumped Water Storage Plant at Lake Muna, Colombia

THE new Lake Muña pumping station of the Empresas Unidas de Energía Eléctrica S.A. of Bogotá, Colombia, provides a good example of pumped storage in which the power station operated by the accumulated water lies at a lower altitude than the storage pumps, so that the effective turbine head is greater than the discharge head of the pumps. It enables a peak output of about 7kW for each kilowatt of surplus power expended in pumping.

The Empresas Unidas de Energía Eléctrica S.A. at present owns two hydro-electric power stations which supply electricity to the Colombian capital, Bogotá, and to the neighbouring towns and villages. Bogotá lies at an altitude of about 8500ft on a plateau about 50 miles in length over which the Río Bogotá flows. Twenty miles or so to the west of the capital, the river begins a fairly rapid descent from the plateau to the Río Magdalena, flowing 7500ft below.

The El Charquito power station, the older of the two installations, is situated just over a mile from the point where the Río Bogotá leaves the plateau. Its four turbine sets operate at a head of 148ft and generate a total output of 5500kW. Apart from these hydro-electric sets, the station has two condensing steam turbines of 3600kW and 8000kW capacity. The boilers are fired with coal mined in the immediate neighbourhood. The second, newer, El Salto power station lies on the river below the El Charquito station, at an altitude of about 6500ft. Its water turbines run with a head of about 1300ft. The plant comprises two turbine sets of 2240kW and three of 10,000kW each. Two further 10,000kW sets are at present being installed.

The rainfall in the catchment area of the Río Bogotá has a very pronounced effect on the level of the river, for there are no natural reservoirs worthy of mention in this area. There are normally two rainy seasons, extending from April to June and from October to December, and separated by two dry periods. The fluctuating level of the Río Bogotá follows the same cycle. During the dry periods it often falls below the minimum needed to meet the normal demands for electricity.

To improve these conditions, the E.U.E.E. early made a reservoir out of the natural Lake Muña (Fig. 1), situated near the point where the Río Bogotá leaves the savanna. The precipitation in the catchment area of this lake permits up to 560 million cubic feet of water to be collected in the rainy seasons and to be supplied in the dry seasons to the Río Bogotá, flowing 105ft below. The natural bed of the Río Muña serves as a supply channel for this water, running as it does into the Río Bogotá about ¾ mile above the El Charquito power station. The outlet from the lake is controlled by a modern sluice installation.

As a result of the continued and rapid increase in the electricity requirements of the city of Bogotá and the surrounding districts, the E.U.E.E. was again obliged to increase the output of its power stations. Accordingly, the reserves of water feeding the Río Bogotá during the dry seasons had to be considerably increased. To this end, the effective storage capacity of Lake Muña was brought up to 1480 million cubic feet by raising the height of the dam, while the natural flow of rainfall to the lake was artificially augmented by means of a pumping station fed from the Río Bogotá during the rainy periods. This project was logical, since the total flow of the Río Bogotá rises in the wet seasons to several times the quantity required for normal operation of the hydro-electric stations, while there is an ample surplus of electricity for pumping. To the left of Fig. 1 the Muña dam can be seen under construction. When the water level is raised to within 3ft of the crest of the dam it then reaches a reference datum of 8563ft.

FIG. 1—LAKE MUNA DAM

Hydraulic Equipment

The new pumping station (Fig. 2) is situated near the confluence of the Río Bogotá and the Río Muña, about ¾ mile above the El Charquito power station. Two Sulzer pumps are installed in the basement of the station building (Fig. 4) and are driven by electric motors from the ground floor. The pumps (Fig. 7) are of special design and are made of high-strength materials. They are designed for the following duties :—

(a) *Operation of Single Pump*

	Minimum	Maximum
Static head :		
Metres	28 ...	32
(Feet)	(92) ...	(105)
Discharge :		
Litres per second	2,400 ...	2,220
(Gallons per minute)	(31,700) ...	(29,300)
Total head :		
Metres	28·9 ...	32·8
(Feet)	(95) ...	(108)
Speed, r.p.m.	593	
Efficiency, per cent	81·5 ...	85
Input, h.p....	1,130 ...	1,140

(b) *Operation of Both Pumps*

	Minimum	Maximum
Static head :		
Metres	28 ...	32
(Feet)	(92) ...	(105)
Discharge :		
Litres per second	4,350 ...	4,000
(Gallons per minute)	(57,450) ...	(52,800)
Total head :		
Metres	33·6 ...	36·8
(Feet)	(110) ...	(121)
Speed, r.p.m.	593	
Efficiency, per cent	86 ...	85·5
Input, h.p....	2,280 ...	2,280

During the acceptance tests carried out on the pumps after installation, an optimum pump efficency of 88 per cent was measured. The

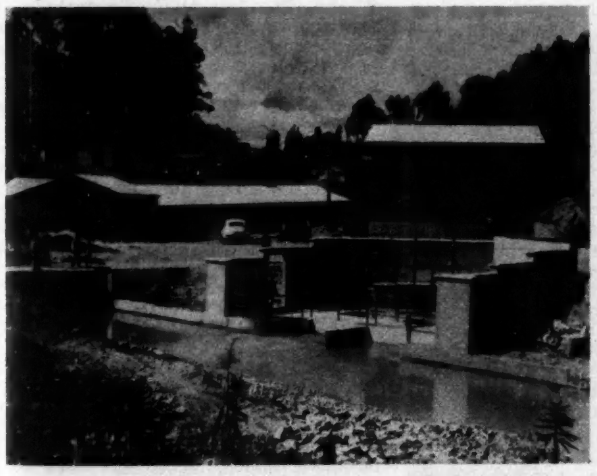


FIG. 2—LAKE MUNA PUMPING STATION

FIG. 3—DISCHARGE PIPE FROM MUNA PUMPING STATION

guaranteed optimum efficiency was thus exceeded by no less than 2 per cent.

Both the vertical pumps (Fig. 7) were machined to tolerances throughout, so that replacement parts can be fitted at any time without preliminary machining being necessary. The volute casing, which is reinforced by annular ribs, opens into a horizontal discharge branch with an inside diameter of 700mm

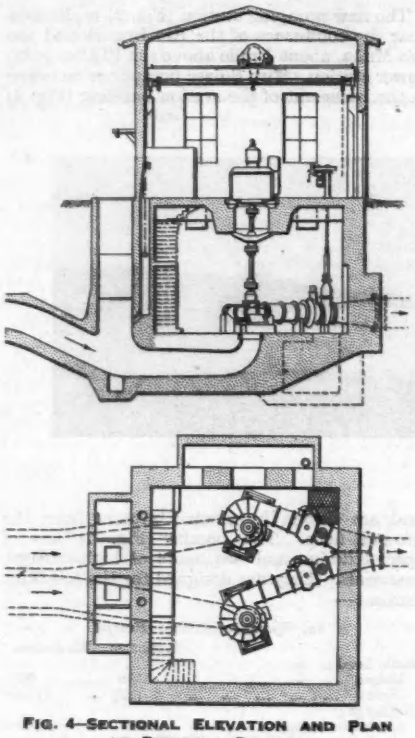


FIG. 4—SECTIONAL ELEVATION AND PLAN OF PUMPING STATION

(2ft 3½in), while the inlet branch, which is integrally cast with the casing, is directed vertically downwards and has an inside diameter of 750mm (2ft 5½in). The steel shaft is protected at the stuffing-box by a sleeve of zinc-free bronze and carries at its bottom end an overhung impeller, also of zinc-free bronze, with Francis blading.

Each of the pumping sets has four guide bearings and one supporting bearing. The guide bearing located on the very strong double-walled pump cover has an ample water-cooling system. That part of the shaft connecting motor and pump (Fig. 4) is guided in a strong intermediate bearing which is attached by brackets to the ceiling of the pump room. The forced-lubrication system of this bearing is of such dimensions that no additional cooling is required. All the bearings are protected by thermostats, whereby should the permissible temperatures be exceeded at any time, an indication is given on the switchboard in the motor room.

Each of the pumps is connected to the Río Bogotá by a separate channel with inlet screen and sluice (Fig. 4). The outlet branch of each pump is fitted with a conical enlargement, followed by a non-return valve with an inside diameter of 800mm (2ft 7½in), and a wedge-type sluice valve of the same diameter. The two pumps deliver through a breeches pipe into a common discharge pipe about 500 yards long, with a diameter of 1350mm (4ft 5in), which was manufactured and laid by a Colombian firm in Bogotá. Fig. 3 illustrates the nature of the terrain.

The wedge-type sluice valves in the discharge pipes can be actuated either by hand or electrically from the motor room. When the pumps are shut down, the valves are first closed and the pump motors then stopped. The rate of closing of the sluice valves is so adjusted that the pressure increase remains within permissible limits. Special measures have also been taken to damp any pressure surges due to the sudden stoppage of the pumping sets. Such surges may occur, for instance, if the current supply to the driving motors fails or the safety short-circuiting device comes into action. In such cases, the water begins to flow back in the discharge pipe until the non-return valves between the sluice valves and the pumps close, more or less rapidly. Very considerable pressure increases may then occur and would endanger the discharge pipe if they were not damped. In the discharge pipe of the Lake Muña Pumping Station, for example, a return flow of only 0·5 metres per second (1·64 feet per second) would, in the absence of damping means, produce a pressure impact of 4kg per square centimetre (57lb per square inch), or approximately that of the normal discharge head. As a shock of this kind would be superimposed on the static pressure, the discharge pipe would thus have to withstand a stress about twice as severe as in normal service. To limit any such pressure impacts to permissible values, the two non-return valves of 800mm diameter have been equipped with by-pass pipes of 200mm (7·9in) diameter, in which hydraulically-controlled valves are installed. The closing period of these valves has been adjusted to 20 to 30 seconds, so that the return flow is gradually throttled before being completely stopped. Any pressure shock caused by the closing of the non-return valve is therefore reduced to harmless values by the open by-pass, after which the reduced return flow continuing through the by-pass pipe is stopped with practically no shock effect by the slow closing of the by-pass valve.

This is, however, not the only precaution taken to ensure the safety of the discharge pipe. With a certain combination of unfavourable circumstances, which are possible but by no means likely, the pressure at the discharge branch of the pump might conceivably drop below the atmospheric. The vacuum thus produced in the discharge pipe, possibly involving even the breakdown of the liquid column, would also endanger the pipe. To preclude this possibility, automatic air-admission valves have been fitted at two suitable points in the discharge pipe, their purpose being to equalise at once any vacuum arising in the pipe. As soon as the pressure in the interior of the pipe falls below the atmospheric, these two air-admission valves open automatically and thus prevent any further pressure drop. To ensure that they do not cause pressure impacts themselves when closing, they are fitted with adjustable oil brakes which slow down the closing process.

A section through the discharge pipe and the dam is shown in Fig. 8. The tower on the left is open at the top and serves as an air vent and surge chamber, acting in parallel with the air-admission valve mentioned above to prevent any sub-atmospheric pressure waves. The end of the discharge pipe which opens into the reservoir is provided with a semi-automatic flap valve (instead of a sluice valve) which is operated by a cable from above. A hand-operated winch is employed for opening the valve. Should the electricity supply at any time fail, so that delivery ceases, the water from the reservoir begins to flow back through the discharge pipe, though the flow may be slight; the valve is then automatically but slowly closed, being braked by a hydraulic damping system fitted in the winch. Closure of the valve is initiated by a pendulum device installed in its immediate proximity in the discharge pipe. This device is ineffective during normal pumping operation, but as soon as a return flow of water commences, the pendulum is brought into action by the water pressure and disengages the pawl of the winch, so that the valve can close slowly by gravity.

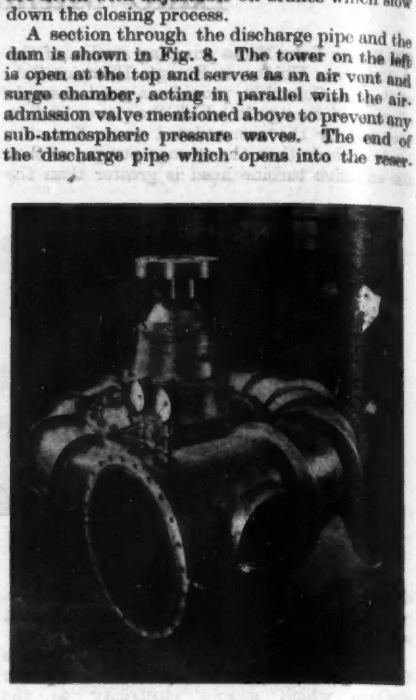


FIG. 7—LOW LIFT PUMP

Just behind this stop valve, the discharge pipe opens into a tower of reinforced concrete (Figs. 6 and 8), in the top of which are four large, square openings. The bottom edges of these openings are at the water level of the reservoir when it is completely full. These openings permit the water delivered by the pumps to flow into the reservoir, even if the stop valve should, for some reason, be closed,

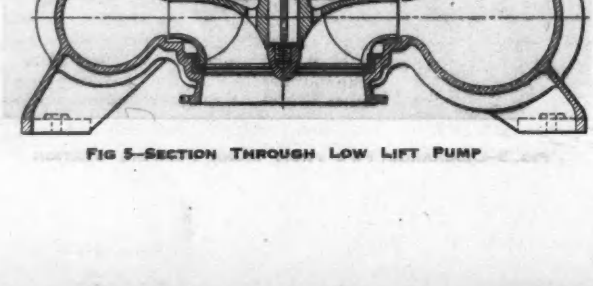


FIG 5—SECTION THROUGH LOW LIFT PUMP

FIG. 6—OUTFLOW CHANNEL AND OVERFLOW TOWER

and should not open under the discharge pressure. The openings are at such a height that the water from the reservoir cannot flow back through them into the discharge pipe, provided that the reservoir is not filled beyond capacity.

Electrical Equipment

The hydraulic power storage pumps are driven by vertical asynchronous motors supplied by Ateliers de Construction Oerlikon of Zurich. The continuous rating of the motors is 1350 h.p. at a speed of 593 r.p.m., a voltage of 6·6kV and a frequency of 60 c/s.

The step bearing which takes the 10-ton load due to pump and motor is located on the upper motor support and is forced-lubricated, its oil circuit being equipped with a gearwheel pump and water recooler. The two bearings fitted in the motor are self-lubricating, and continue to be so even in the event of reverse running, which is very improbable in practice, as non-return valves are fitted in the discharge pipes in the close vicinity of the pumps, while a special device automatically closes all the sluice valves when the pumps begin to turn backwards, however slowly. Finally, the stop valve at the top of the discharge pipe would also close automatically if any return flow should occur.

The motors are slip-ring machines, equipped with a hand-operated brush-lifting and short-circuiting device. False switching operations are prevented by the interlocking contacts of motors and starters. The main and auxiliary lines are connected up to cable end boxes. Cooling air for the forced ventilation of the motors is drawn from the pump room and expelled into the motor room.

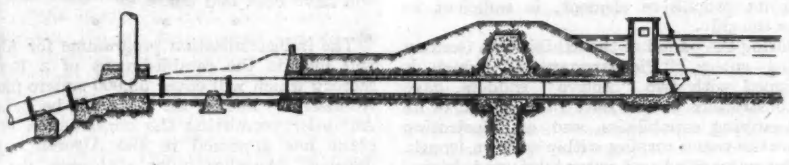


Fig. 8—Section Through Dam and Discharge Pipe

The switchgear and protective equipment are accommodated in a five-panel switchboard. The oil switches are fitted in the outgoing motor lines, while thermal relays are provided in two of the phases. The starters are also housed in the switchboard, and are operated by handwheel from the control station.

The supply line from the mains of the E.U.E.E. is provided with the requisite instrument transformers and instruments for measuring current, voltage and power, and with minimum-voltage and time relays which shut down the motors and close the sluice valves in the event of any excessive drop in the voltage or the complete failure of the supply. Various signal relays indicate at a glance the cause of any irregularity in service. The motor room has a small switchboard containing the fuses for the auxiliary services, besides the main switchboard already mentioned. The smaller board is also equipped with a charging unit for a 24V battery, to which the control and signal circuits are connected, to provide continuity of service independently of the external supply.

Operation of the pumping station is semi-automatic. As a rule the staff carries out the operations necessary for starting and stopping the pumping sets. When irregularities occur, however, the sluice valves are automatically closed and the motors at the same time cut out. Such disturbances are indicated by special signals not only in the motor room, but also in the control room of the nearby El Charquito power station.

Power Balance

The two pumping sets of the Lake Muña pumping station have a total discharge of about 140 cubic feet per second, while they require an input of about 1780kW. These requirements are met by the use of low-value surplus current, and the water thus stored permits peak-load power of high value to be generated during the dry seasons in the El Charquito and El Salto power stations.

The Lake Muña pumping station is believed to be the only plant of its kind in South America. The first pumping set was put into service on October 10, 1949, and the whole pumping station on November 30, 1949. On December 31, 1949, 810 million cubic feet of water was stored in Lake Muña, compared with 390 million cubic feet at the same time in the previous year. The two low-lift pumps, with their valves, for the new storage pumping station were supplied by Sulzer Brothers, Ltd., of Winterthur, Switzerland. All the electrical equipment was provided by Ateliers de Construction Oerlikon of Zurich. The design of the complete pumping station was prepared by Motor Columbus, S.A. d'Entreprises Electriques of Baden.

Economic Justification for Road Works *

Roads differ from most other forms of capital asset, in that their users, although requiring them as part of the equipment essential to their business and other activities, in most cases have no direct influence either over the amount of capital investment in new or improved roads or over the standard of road maintenance.

The need for an economic approach to road works has received belated recognition, due to the growth of motor traffic and a more general appreciation of the wisdom of taking a broad view of the community's capital assets. The principle which is now emerging is one of obvious common sense, viz., that the cost of every proposed road work should be compared with the value of the economic benefits which it would produce.

In most countries the Governments are to-day taking a considerable interest in capital expenditure as a whole in order to ensure that, from the community's point of view, the best possible use is made of the investment capital available. The basis of any sound economic policy must be that a proper balance is maintained between the different claims on resources. A combination of a perfect road system with obsolete industrial capital would be just as ill-conceived as a policy of improving industrial equipment and housing while neglecting the roads. Investment must keep in step on all fronts, and the problem is to determine how much of a community's resources can, at a particular stage of development, properly be earmarked for the improvement of the road system.

In the United States it is now generally accepted that the highway engineer should concern himself with the economic justification of road works.

The District Engineer, Public Roads Administration, put the point very clearly and concisely when he said that "the road building agencies should be considered as functioning at the service of motor vehicle users for the purpose of aiding in the improvement of motor vehicle transportation and reducing its cost." This approach is gaining general acceptance among highway engineers, so far as it does not conflict with the legitimate interests of other highway users, but it has not so far been matched by any similar awareness on the part of many Governments. There is still too widespread a tendency for Governments in their Budgets to regard road expenditure as merely a semi-luxury item, which can well be pruned. The adverse effect of the pruning on the cost of operating road transport, whenever there is need for economy or whenever calls are made for increased expenditure in other directions, is often ignored. In fact, there is an all too common tendency for Governments to seek to alleviate the economic situation of a country by neglecting the upkeep and improvement of one of their most important capital assets, the roads.

In the field of financial policy there should be a direct relationship between the moneys collected in taxation from vehicle operators and the moneys allocated to the roads. Where this has been established it is possible, as happened in California in 1949, for an increase in motor taxation to be willingly accepted by vehicle operators in the knowledge that the proceeds would be applied to the improvement of the road system and the consequent overall reduction of their costs of operation.

It has been calculated that expenditure on motor vehicle operation on the British highway system in 1949 amounted to £1,039,000,000, or 10·1 per cent of the total national income of £10,226,000,000. This expenditure related to something of the order of 28,000 million vehicle-miles run on British roads, involving 1400 million vehicle-hours on the roads. The average cost of these operations was thus 8·91d. per vehicle-mile and 14s. 10d. per vehicle-hour.

Expenditure on operating road vehicles amounts to some 70 per cent of the total British expenditure on all kinds of inland transport and it absorbs a steadily increasing proportion of the national income, as in most other countries. In spite of this the new capital expenditure on the roads since the beginning of the motor era has been relatively small. During the last thirty years new road construction has absorbed only £80,000,000, which compares with a current programme of £400,000,000 for capital investment in electricity generation and distribution.

A programme of road construction and improvement, estimated to cost £550,000,000, would promise a saving to British motor vehicle operators of £95,000,000 a year on the basis of the 1949 volume of traffic, a figure which would increase rapidly with the further growth in the number and use of motor vehicles. The economies indicated fall under five heads :—

(1) Saving in time through higher average speeds and fewer undesired stops.

(2) Saving in fuel through reduced traffic congestion.

(3) Saving in tyres through fewer undesired stops and smoother flow of traffic.

(4) Saving in repairs and maintenance through smoother flow of traffic.

(5) Saving in accidents from segregation of different types of traffic and fewer opportunities for traffic friction.

The methods of construction and maintenance of a road system should be related, not only to the traffic which is being carried, but also to the traffic which it is expected will be carried in the future. Apart from the continued use of stone setts in some towns and industrial areas and of wood blocks in London, the roads in Britain are to-day suitable, so far as their surfaces are concerned, for carrying motor traffic at normal speeds up to the legal weight limits of motor vehicles. However, the problem which must be faced in the future is not that of adapting the road system to carry traffic of substantially different type from that at present using it, but of enabling it to carry a much greater volume of traffic of the existing kind and to carry it both with greater safety and at a higher average speed.

Traffic on British roads is still increasing rapidly and there is little likelihood of this trend being checked. There is reason to think that the growth of traffic has been even greater than the increase in the number of vehicles; apart from private cars, motor vehicles appear to be used more intensively than in 1939.

Standardisation in the processes of construction and major improvement may also be expected to lead to standardisation in methods of maintenance, where the effect of the growth

* Extracts from a paper by C. T. Brunner, R. Gresham Cooke, W. H. B. Cotton and J. Drake, at the Fourth Congress of the Permanent International Association of Road Congresses at Lisbon.

of traffic will be a demand that maintenance work should be concentrated into as short a period of time as possible, in order to avoid disruption of normal traffic flows. This will mean in practice that small groups of "pick-and-shovel" men will be increasingly replaced by the mobile gang equipped with mechanical aids. The tendency will be to close a section of road completely for a short time, detour the traffic and concentrate on completing the work as quickly as possible. It is essential that the highway engineer should know well in advance how much money will be available, preferably over a period of years, so that he may prepare and execute the most effective maintenance programme.

The cost of road accidents in Great Britain was the subject of a report to the Minister of Transport by Professor J. Harry Jones in 1946, who estimated that the total annual cost to the community of road accidents during the period 1935–38 was approximately £60,000,000 in respect of 528,000 accidents occurring annually, an average of £113 per accident. This sum represented roughly 1·33 per cent of the national income. The comparable cost at 1950 price levels would be around £120,000,000, or £226 per accident.

The saving in accidents by the construction of improved types of road has been the subject of investigation in many countries. For example, in the report of the Select Committee of the House of Lords it was stated that the construction of the German autobahnen resulted in a reduction of persons killed during 1935–37 by 34 per cent on all roads, although the number of motor vehicles increased by 32 per cent. The proportionate number of accidents on the new autobahnen was only 17 per cent of the number on the old State roads. Again, on the Chicago Lake Shore Drive the accident rate is only 0·8 per million vehicle-miles, compared with 18·9 on ordinary roads in the area.

A comprehensive investigation was carried out in connection with the preparation of the road plan for Lancashire, which demonstrated the value of particular forms of road lay-out and design, and gave indications of the saving in accidents possible by various forms of improvements.

Some 41 per cent of all accidents occur within 50 yards of a junction, and it has been calculated that the incidence of accidents is about thirteen times as great near junctions as at places remote from them.

The "Active" Rudder

At the Engineering Marine and Welding Exhibition, Pleuger and Co., of Hamburg, showed, in addition to various examples of pumps, models of the "Active" rudder which it has recently developed. The models on view included a twin rudder installation on a ferry and the application of the device to an 8000-ton cargo ship. Our illustration shows the model of a merchant vessel with the "Active" rudder fitted. The thrust from the rudder is sufficient to give steerage way to the ship so that manœuvring can be carried out without using the main engines.

The rudder is of conventional streamlined form, and is fitted at about half-height, with a torpedo-shaped casing which houses a waterproof a.c. squirrel-cage motor driving a propeller. Control of the rudder is by the normal forms of steering gear, but the thrust of the auxiliary propeller is in line with the angle of helm, thus assisting to turn the ship and resulting in improved manœuvring qualities. The illustration of the merchant ship application shows a shroud around the rudder propeller, but for small craft no main motor and stern gear are necessary, since, within the limits of the power available, the "Active" rudder, with its propulsive element, is sufficient to drive the ship.

Turning Circle Using "Active" Rudder

During the period of the exhibition a German fishing cutter, "Pleugerpump 2," which is equipped with two "Active" rudders, gave demonstrations in the East India Dock, of its manœuvring capabilities, and an illustration shows the vessel turning within its own length.

The water-filled and water-lubricated driving motor is available in units over a power range from 50 h.p. to 300 h.p., all running at 750 r.p.m., and taking power from an a.c. generator. The fitting of the rudder necessitates certain minor alterations to existing steering gear in order to accommodate the greater effective rudder angle, which may be increased to 70 deg., and also modifications to the rudder bearings due to the increased load occasioned by the additional thrust of the "Active" rudder.

Merchant Ship Model

Grey Ironfounders' Productivity Report.—The Council of Ironfoundry Associations has prepared a summary of the report of the specialist team of the grey ironfounding industry, which was published recently by the Anglo-American Council on Productivity. The summary emphasises, in simple language, the main findings and conclusions of the team following its visit to the U.S.A., and has been produced specially for circulation amongst the 150,000 workpeople in the British ironfounding industry. Further information about this publication can be obtained from the Council of Ironfoundry Associations, Crusader House, 14, Pall Mall, London, S.W.1.

French Engineering News

(From our French Correspondents)

By the end of this year, Electricité de France will have completed its programme for constructing a 15kV network of power transmission lines for the industrial zones around Rouen and a 30kV network to give a low tension supply to the entire regions. In addition a systematic check on existing low tension lines has been made to remedy the lack of maintenance during and since the war.

* * *

Because of the modernisation of the steel industry and the increase in production, French iron ore production will have to be increased. It is estimated that by the end of 1953 ore production in France should be about 40 million tons, against the 33 millions of 1938. It is thought that mechanisation will have to be extended to increase production and that manpower is not the problem. In 1935 only 5 per cent of the Lorraine ores were handled mechanically, with thirty-two machines. There are now 300 machines in the area, handling 60 per cent of production, and it is estimated that by 1954 some 80 per cent of production will be handled mechanically, with 470 machines. About £20,000,000 is being spent on modernisation and out of this sum £18,000,000 will go to the modernisation of the Lorraine area. £11,000,000 has already been spent and it is hoped that by the end of 1951 some 70 per cent of the total will have been laid out.

* * *

The industrialisation programme for Algeria will include the establishment of a Renault factory which will cover 58,000 square metres. An assembly line for the C.V.4 will be installed. An order permitting the construction of the plant has appeared in the Algerian *Official Journal*. Another order authorises the construction of a sheet metal plant.

* * *

A miniature compression-ignition engine is to be adapted for the toy industry in France. Joachim Bader built the engine, which has a cylinder of 15mm and weighs no more than ½ lb. It is constructed in aluminium alloy with a steel piston.

* * *

In the first six months of 1951 French heavy industry constructed 61 locomotives and 3969 railway trucks. The tonnage in June amounted to 10,120 against 9540 tons in May, 8000 in April and 9330 in March. In July France exported 10,660 tons of rolling stock against 11,470 tons in June and 12,190 tons in May. Apart from the locomotives and trucks constructed in this six months some 48 tenders were built, 33 shunting engines, 117 passenger coaches and 98 "Autorail" cars and trailers.

* * *

Paris is to replace its present gas street lighting with fluorescent lighting; 32,000 gas burners are in use at present in the city's streets. The replacement of 8000 by fluorescent lamps has started.

* * *

Charbonnages de France has announced that French coal reserves now stand at 11 milliard tons and are fifth in Europe after Germany, Britain, Poland and Czechoslovakia. Production per miner continues to rise steadily and reached a record of 1 ton 320kg per day last May. The average for the eight months of 1951 was 1 ton 229kg per day, or 8 per cent more than the 1950 average. Production has gradually risen above all pre-war figures. The first six months produced 27,627,000 tons, against 27,500,000 tons for the first six months of 1930, which was previously the largest figure Estimated production for 1951 is 55 million tons, or 2½ million more tons than in 1950.

* * *

The 16,500 tons "Roussillon" has been launched by its builders, the Ateliers et Chantiers de la Seine-Maritime. The "Roussillon" is a tanker and sister ship of the "Champagne," which was launched in October, 1950.

Industrial and Labour Notes

Average Earnings and Working Hours

The Ministry of Labour has recently published its half-yearly survey of average weekly earnings and working hours. It relates to the last pay week of April, 1951 and is based upon information received from about 58,700 industrial establishments in the United Kingdom, employing altogether approximately 6,500,000 workpeople. Among the employments not included in the Ministry's inquiry were agriculture, coal mining and the railway, shipping and port transport services.

The survey shows that in the last pay week of April the average weekly earnings in all the industries examined were as follows: men, £8 0s. 2d.; youths and boys, £3 6s. 11d.; women, £4 7s. 4d., and girls, £2 15s. 11d. These figures, it should be noted, are general averages, covering all classes of manual wage earners, including unskilled workers and general labourers, as well as operatives in skilled occupations. Taking the industry group classified by the Ministry of Labour as "engineering, shipbuilding and electrical goods," the average earnings in the week surveyed were: men, £8 5s. 11d.; youths and boys, £2 19s. 10d.; women, £4 9s. 6d., and girls, £2 14s. 7d. Average hourly earnings of men in those trades in the last pay week of April were 3s. 5·4d. The survey states that, on the average, weekly earnings in the industries investigated were, for all workers, 156 per cent higher in April last than in October, 1938; men's earnings being 132 per cent higher, youths' and boys' 157 per cent, women's 169 per cent, and girls' 202 per cent. Since April the survey points out, there have been increases in the rates of wages in a number of industries. It is estimated that those increases have raised the general level of full-time weekly wage rates by approximately 2 per cent during the four months May to August, 1951.

The average hours worked in the last pay week of April in all the industries coming within the scope of the inquiry were: men, 47·9; youths and boys, 44·5; women, 42; girls, 42·7. In the manufacturing industries the average hours worked were slightly below those figures, although in the engineering, shipbuilding and electrical goods group, the average hours were: men, 48·1; youths and boys, 44; women, 42·5, and girls, 42·5.

Electricity Supply and Capital Resources

At the annual meeting of the General Electric Company, Ltd., which was held in London on Thursday of last week, Sir Harry Railing, in the course of his chairman's address, emphasised the need for sufficient capital resources in the electricity supply industry. The present position of that industry, he said, showed the grave damage done to the community if sufficient capital was not available.

The present shortage of generating plant, Sir Harry continued, could not be laid at the door of the British Electricity Authority's administration. It was almost entirely due to the fact that the post-war Government did not recognise—or did not have the strength to insist upon—the necessity of providing early enough sufficient capital for electricity supply, the most important tool upon which this country's increased and efficient production depended. Before the outbreak of war, Sir Harry recalled, both the Central Electricity Board and the electrical manufacturing industry had insisted on the need for an accelerated programme.

At that time, Sir Harry said, the horsepower per man in the United Kingdom was half that of the U.S.A. During the war it was impossible to bridge the gap, yet before "D" day the heavy electrical plant committee asked for an immediate acceleration. That led to a demand for an increase in yearly manufacturing capacity to 2500MW and, in the plant programme at home, for 1500MW, rising to 2000MW. The electrical manufacturing industry created the required capacity yet the national supply programme had been continually thwarted, first by subordinating it to demands for steel and buildings for other purposes and afterwards by the Government's failure to set aside, sufficiently early, capital for the full extensions which were obviously vital. That insufficiency, Sir Harry declared, combined with the shortage of coal, constituted the most serious bar to increased production, to the efficient use of available manpower and, therefore, to our progress.

Sir Harry went on to say that the U.S.A. provided 6500MW of additional plant per year for a population of 150,000,000, and he claimed that our proportional programme in the United Kingdom should exceed 2000MW, leaving out of consideration the present grave deficiency. Yet, he pointed out, the programme even for three years hence fell 25 per cent short of that figure. Such a state of affairs, Sir Harry asserted, was a glaring example of what was bound to happen if the demands for essential industrial capital were subordinated to claims for other forms of expenditure, however desirable they might appear.

Changes in Wage Rates

Changes in wage rates reported to the Ministry of Labour as coming into operation in the United Kingdom during August, resulted in an aggregate increase of about £324,000 in the weekly full-time wages of 1,165,000 workpeople. Among those receiving increases were workers in the iron and steel industry, electricity supply undertakings, certain engineering, supplies and motor transport sections of the Post Office and operating staff employed by the Road Haulage Executive.

In the iron and steel industry the increases were made under sliding scale arrangements, based on the index of retail prices. For workers in the electricity supply industry the increase was twopence an hour in the scheduled rates of wages and was retrospective to the beginning of June. Operating staff employed by the Road Haulage Executive received increases of 7s. a week for adult workers and of 2s. 6d. to 6s. for younger workers.

It has been estimated by the Ministry of Labour that during the first eight months of this year about 8,502,500 workpeople received pay increases aggregating £3,618,000 a week. There were no decreases in wage rates during that period. In the corresponding months of 1950 there was a net increase of £521,000 in the weekly full-time wages of 2,818,500 workpeople.

Expanding Canadian Markets

Recent discoveries and future developments in Canada, resulting in increasing markets for engineering equipment, were referred to by Mr. Leslie Brown, Assistant Director of the Foreign Trade and Overseas Service, Canadian Government Department of Trade and Commerce, in an address to the Central London group of the Engineering Industries Association on September 26th. Dealing with discoveries of iron ore in Labrador and Quebec, Mr. Brown said that work on opening up the deposits was going forward very rapidly and, in a few years' time, the growth of population accompanying these developments would make the districts great buying areas. A similar development had already started in northern British Columbia, where there were but a few scattered villages with a population probably not exceeding 20,000. In that large watershed the Aluminium Company of Canada had already made progress in a scheme which would ultimately involve an expenditure of over 500,000,000 dollars, an expenditure that meant the growth of new centres and of new consuming industries. In Alberta, Mr. Brown continued, there had been oil discoveries. The Government of Alberta was regulating their development in a way very satisfactory to the large amount of capital already invested there—an investment which at present exceeded 300,000,000 dollars. With gas and petroleum as fuel and raw material, Alberta was becoming a centre for industrial development, which already included chemicals and wood cellulose, as well as the products of petroleum.

These three outstanding developments, Mr. Brown suggested, would mean an expanding market in Canada for consumer goods as well as engineering and technical equipment. The markets could provide an outlet for British exports but, he commented, the opportunity was, of course, not unknown to competitors in other countries. It was, therefore, essential that British products should be made known in Canada now, even though deliveries might be late and even if orders came in slowly. The Canadian user was already thinking of the time when scarcities no longer hampered developments and his plans could go ahead more rapidly. If the British manufacturer waited until that time to show the Canadian his goods he would be too late.

Trade Disputes

The number of stoppages of work on account of industrial disputes, reported to the Ministry of Labour as beginning in August, was 139. In addition, twelve stoppages, which started before August, were still in progress at the beginning of that month. In these 151 stoppages about 22,300 workers were involved directly and indirectly during August, with the result that 73,000 working days were lost. In the preceding month there were 112 stoppages reported, affecting 17,200 workpeople and causing an aggregate loss of 42,000 working days. The majority of the stoppages in August again occurred in the coal mining industry, in which 23,000 working days were lost by 11,700 workers.

The Ministry of Labour's statistics show that in the first eight completed months of this year there were 1148 stoppages of work through disputes. They involved 276,200 workpeople and caused an aggregate loss of 1,335,000 working days. In the comparable period of 1950, there were 936 stoppages reported, resulting in a loss of 891,000 working days by 207,000 workpeople.

Price Changes

The Ministry of Materials has announced that, as from October 1st, the price of imported good soft pig lead has been reduced from £180 to £175 per ton, delivered to consumers' works. This reduction, it is explained, has been made possible by improved terms of supply agreed with Commonwealth producers. No change will be made for the time being in the Ministry's selling price for zinc. The Ministry of Supply is making arrangements for appropriate adjustments in the controlled prices of lead scrap.

The Ministry of Materials has also announced an Order, with effect from October 1st, permitting increases in the maximum prices of sulphuric acid. The additions to maximum prices are 14s. a ton on weak acid (77 per cent H_2SO_4) and 27s. a ton on strong acid (more than 84·02 per cent H_2SO_4). The increases, the Ministry says, are the result of a rise in the price of imported pyrites and in freight rates for both sulphur and pyrites.

Semi-Manufactures of Copper and Zinc

For the two quarters since April 1st last, exports of semi-manufactures of copper and copper alloys have been restricted to approximately half the rate prevailing in the first six months of 1950. The Board of Trade has announced that, because of the continuing world shortage and the high demand for these semi-manufactures for essential purposes, the restrictions are to be extended in the same form for a further period of three months from the end of September. Another announcement will be made before the end of the year. The export of semi-manufactures of zinc will continue to be permitted only in exceptional circumstances.

Notes and Memoranda

Rail and Road

RAILWAY WAGE NEGOTIATIONS.—At a meeting of the Railway Shopmen's National Council last week, the trade union representatives submitted an application for a substantial increase in the rates of pay of railway workshop staff. The representatives of the Railway Executive undertook to consider the submissions and to arrange a further meeting as quickly as possible to give their reply.

B.R. LOCOMOTIVE "AMETHYST."—The London Midland Region of British Railways has given the name "Amethyst" to its "Jubilee" class locomotive No. 45,700, to commemorate the exploit of the frigate of that name which, in 1949, ran the gauntlet of heavy and continuous bombardment from the shore for over seven hours as she sailed down the Yangtse. The locomotive No. 45,700 is one of 191 of the "Jubilee" class built by the former L.M.S. in 1934–6. They were designed by Sir William A. Stanier, F.R.S., and haul express trains on the main lines of the London Midland Region and Scottish Region.

RETIREMENT OF MR. F. H. ELIOT.—Mr. F. H. Eliot, assistant for outdoor machinery to the Executive Officer (Electrical Engineering New Works and Development), Railway Executive headquarters, has recently retired. Mr. Eliot studied at Goldsmith's College and the City and Guilds of London Institute, and began his railway career in the drawing-office of the Engineer-in-Chief, Great Eastern Railway, Liverpool Street, in 1901, transferring subsequently to the electrical department. In 1924 he was appointed chief draughtsman in the office of the electrical engineer, L.N.E.R., King's Cross, and later became chief draughtsman and technical assistant. On the formation of the Railway Executive's electrical engineering new works and development organisation in March, 1950, Mr. Eliot was appointed assistant for installations, lighting and appliances, the designation of this post being later altered to assistant for outdoor machinery.

Air and Water

U.K./SCANDINAVIAN AIR AGREEMENTS.—Negotiations between delegations from Denmark, Norway and Sweden and a United Kingdom delegation were recently concluded by the initialling of bilateral agreements between the United Kingdom and each of the Scandinavian countries, governing the exchange of air transport rights. The agreements, which are subject to the approval of the Governments, recognise the special position of S.A.S. as the joint organisation which operates on the routes and exercises the traffic rights in which the three countries are interested. The agreements cover the exchange of rights on routes between the United Kingdom and Scandinavia and on routes to Africa, the Far East and North America.

NEW COAL SHIPPING STAITHES.—The Tyne Improvement Commissioners are to build two new coal shipping staithes at Whitehill Point to accommodate vessels having a draught of 30ft. Wagon tipplers will provide for the rapid shipment of washed small coal, each staithe having two radial arm loaders for the simultaneous filling of two holds, and electric conveyor belts will transfer the coal from hoppers under the wagon tipplers to the loaders. The new staithes will provide modern facilities for shipping South Northumberland coal, one staithe replacing No. 2 staithe, which was burned down in 1938. The other will be on the site of No. 1 and No. 2a staithes, which are to be demolished. Craft at present using No. 2a staithe will be accommodated elsewhere and additional wagon standage sidings are to be constructed.

HIGH TENSILE STEEL FOR CANAL BOATS.—Three 50-ton Liverpool type motor canal boats, which are under construction by the Fairmile Construction Company, Ltd., for the North-Western Division of the Dock and Inland Waterways Executive, are being built of B.S.S. 968 high tensile steel and have welded instead of riveted joints. The steel has a yield point of 22 tons per square inch and the tensile strength is 37 to 43 tons per square inch for plates and 35 to 41 tons per square inch for sections. Lighter scantlings have been possible and the saving in steel weight plus the use of welding represents an increase in deadweight of between 4 and 5 tons. There has been no increase in cost because the higher price of the metal was offset by the reduced amount of steel. The boats, which are 61ft long by 14ft 3in beam by 4ft 8in moulded depth and driven by 30 b.h.p. Widdop diesel engine, will be plated in Cor-Ten, a low alloy, high tensile structural steel, containing 0·25 to 0·5 per cent of copper, which is claimed to have four times the corrosion resistance of mild steel. The building of these craft in aluminium alloy has been investigated. The constructional weight would be less than half that of the steel boat but the cost would be 63 per cent higher.

Miscellanea

INTERNATIONAL FOUNDRY COURSES.—The International Foundry Congress, which was held in Brussels last month, was attended by about 500 delegates from seventeen countries. The *mémoires* of the congress have been published, consisting of forty-five pages, some in French and some in English. In each case, a summary of the paper is given in the second language. Copies may be obtained from the Congrès International de Fonderie, 1951, 21, Rue des Drapiers, Bruxelles, Belgium, at a price of 500 Belgian francs.

NEW MEMBER OF THE ADVISORY COUNCIL FOR SCIENTIFIC RESEARCH.—The Lord President of the Council has appointed Professor Sir Eric Rideal, F.R.S., to be a member of the Advisory Council for Scientific and Industrial Research from October 1st. Sir Eric is Professor of Physical Chemistry at King's College, London. He was Professor of Colloid Science, Cambridge University, from 1930 to 1946, and Fullerian Professor of Chemistry and Director of the Davy-Faraday Research Laboratory at the Royal Institution from 1946 to 1949. Professor H. W. Melville, F.R.S., retired from the Council on September 30th on completion of his period of service.

PETROLEUM INDUSTRY EXHIBITION.—The Exhibition of the Petroleum Industry, which has visited the Universities of London, Glasgow, Leeds and Cambridge, has been invited to three other university towns and will be on view at these places between October, 1951, and January, 1952. The first additional showing will be at the Museum and Art Gallery, Leicester, from October 8th to October 27th, and it will be at the Firth Hall of Sheffield University from November 8th to November 17th. Finally, the exhibition will move to Edinburgh, where it will be presented in the Royal Scottish Museum on December 17th, and will remain until January 27th, 1952.

NEW TOWN AT CONGLETON.—The Minister of Local Government and Planning has decided that he should take formal steps under the New Towns Act, 1946, towards setting up a Development Corporation to build a new town at Congleton, Cheshire. The main object of the new town will be to assist in meeting the "overspill" problem faced by local authorities in South Lancashire. In selecting Congleton careful consideration has been given to the problems of providing water and other services, to the avoidance of land where there is a danger of subsidence due to salt mining, and to the desirability of keeping off high-grade farm land. The Minister is now consulting all the local authorities concerned.

ASSOCIATION OF CONSULTING ENGINEERS.—The annual report of the committee of the Association of Consulting Engineers, for the year ended April 30, 1951, has recently been issued. During the year thirty-four new members joined the Association, which now has a total membership of 327. The work carried out during the year included the presentation of a report, prepared by a committee of the Association, to the Minister of Health giving the Association's views on the proposed nationalisation or regionalisation of water supplies. The Councils of both the Institutions of Mechanical and Electrical Engineers have approved of the name of the Association, as a joint sponsor, being added to the names of the two Institutions on the front cover of the next issue of the Model Form of General Conditions of Contract.

OBITUARY.—We have learned with deep regret that, among the passengers who were killed in the train derailment at Weedon, Northants, on September 21st, was Major Leo Zinovieff, M.I.C.E., A.C.G.I., of Messrs. Sandford Fawcett and Partners, consulting engineers, of Westminster. Major Zinovieff, who was forty-six, had practised as a consultant for some years, and joined Sandford Fawcett and Partners in 1940. He was taken into partnership in 1948. Among the works with which he was closely associated in recent years was the Colne Valley sewage disposal scheme. Earlier in his career he had been engaged as an assistant engineer on the design and construction of the Shannon hydro-electric scheme. We have been informed that the fatal casualties in the Weedon disaster included Mr. C. C. Howis and Mr. F. Walker, who were both on the research staff of British Insulated Callender's Cables, Ltd. Mr. Howis was manager of that company's chemical research laboratory at Kirkby, Liverpool, and Mr. Walker was a research metallurgist.

Personal and Business

SIR RICHARD YEABSLEY, C.B.E., has joined the board of F. Perkins, Ltd., Peterborough.

MR. J. T. A. BROOKS, F.R.I.C.S., has been appointed chief quantity surveyor, Ministry of Works, in succession to the late Mr. C. A. Morrison.

FOUNDRY SERVICES, Ltd., Long Acre, Nechells, Birmingham, 7, announces the appointment of Mr. M. W. Barlow as manager of its newly established ferro-alloy division.

DR. H. E. MERRITT, M.I.Mech.E., chief research officer, British Transport Commission, has been appointed chief administrative engineer to the Rootes Group at its Coventry factories.

MR. L. B. STONE, Riversley, Cashes Green Road, Cainscross, Stroud, has been appointed honorary secretary of the Gloucester branch of the Institution of Engineering Draughtsmen and Designers.

M.T.E. CONTROL GEAR, Ltd., Leigh-on-Sea, Essex, announces the opening of a Midlands area office at 47, Warwick Road, Coventry (telephone, Coventry 64561). Mr. J. A. Fishpool is branch manager.

INSURANCE ENGINEERS, Ltd., Moray House, 23–31, Great Titchfield Street, London, W.1, states that Mr. W. H. Forster, M.I.Mar.E., has been appointed assistant chief engineer and assistant manager.

THE UNITED STEEL COMPANIES, Ltd., state that the secretarial, library and information staffs of the research and development department have now been transferred to Swinden Laboratories, Moorgate, Rotherham.

THE BRITISH ELECTRICITY AUTHORITY states that Mr. R. S. Atkinson, A.M.I.Mech.E., A.M.I.E.E., generation engineer (operation), in the S.E. division, has been appointed Group I generation engineer (operation) in the London division.

MR. C. A. HALL, A.M.I.E.E., has relinquished his position as manager of the industrial motor sales department of the British Thomson-Houston Company, Ltd., to join the secretariat of the British Electrical and Allied Manufacturers' Association.

SUNVIC CONTROLS, Ltd., has moved to a new factory on the industrial estate at Harlow New Town, Essex. The sales department of the company is now at 132–135, Long Acre, London, W.C.2, and the registered office continues at 10, Essex Street, Strand, London, W.C.2.

THE BRITISH THOMSON-HOUSTON COMPANY, Ltd., Rugby, announces the following appointments:—Mr. R. G. A. Dimmick, M.I.E.E., A.M.I. Mech.E., manager of the industrial motor sales department; Mr. H. R. Canning, manager of the marine department; Mr. A. G. W. Cannon, manager of the Birmingham works.

BRADES AND NASH TYZACK INDUSTRIES, Ltd., announces the formation of an overseas sales company, to be known as Brades and Nash Tyzack Industries Overseas, Ltd. Mr. Peter Boulton is managing director and Mr. G. L. Rowberry will act as director in charge of the new organisation, the offices of which are at Brades Steel Works, Oldbury, Birmingham.

THE METROPOLITAN-VICKERS ELECTRICAL COMPANY, Ltd., Trafford Park, Manchester, announces the appointment of Mr. C. T. Scarf as chief engineer, industrial control department, in succession to Mr. G. L. Newman, who has been transferred to the chief electrical engineer's staff. Mr. G. D. Harradine has been appointed assistant sales manager, industrial control department.

MR. KENNETH PRESTON, chairman and managing director of J. Stone and Co. (Holdings), Ltd., has resigned from the board of The Superheater Company, Ltd., and Mr. W. J. Ruston, director of J. Stone and Co. (Holdings), Ltd., and chairman of Ruston and Hornsby Ltd., has been appointed in his place. Mr. L. C. Southcott and Mr. E. Lawton have been appointed special directors of The Superheater Company, Ltd.

British Patent Specifications

When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

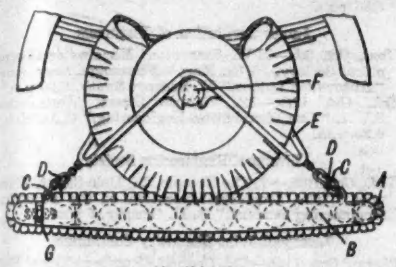
Copies of specifications may be obtained at the Patent Office Sales Branch, 25, Southampton Buildings, Chancery Lane, W.C.2, 2s. each.

AUTOMOBILE ENGINEERING

656,680. May 9, 1949.—Track Vehicle Fittings, Brien Raymond Symes, East Hyde Farm, Tillingham, Essex.

This invention relates particularly to methods and apparatus for readily converting wheeled vehicles to the form of track vehicles.

The fitting consists of a track member *A* running on a series of internal rollers *B* and provided with chains *C* having quick release hook-links *D* securing it to a stirrup member *E*. The stirrup is mounted on one side on a projection



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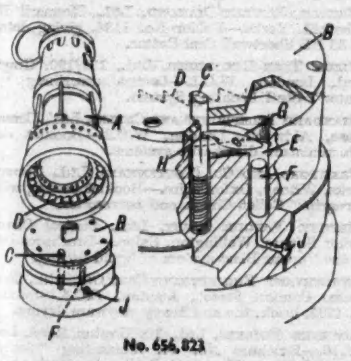
F on the hub of the wheel and on the other side on a sleeve on the wheel axle. On the inside of the wheel stops, which limit the possible angular movement of the track member, are provided. A screw fitting *G* enables the tension of the track to be adjusted by movement of the end rollers. The specification illustrates the assembly of the track members and shows a vehicle with both forward and rear wheels provided with track fittings and the action of the fittings in carrying the vehicle over rough ground. A track member fitted to a double axle, double-tyred vehicle is also illustrated. *August* 29, 1951.

MINING MACHINERY

656,823. January 10, 1949.—Safety-Lamp Locking Device, The Minister of Fuel and Power, 7, Millbank, London, S.W.1 (*Inventor: Harry Lloyd*).

The lamp is opened by unscrewing the top portion *A*, comprising the lantern and hood from the base *B*, which forms the fuel reservoir and wick-tube. According to the invention, unauthorised opening of the lamp is prevented by the engagement of a spring-loaded latch *C*, sliding in a tubular cavity formed in the base, with a ratchet ring *D* forming part of the top portion of the lamp, when the two parts of the lamp are screwed together. The lamp thus locked can be opened only by with-



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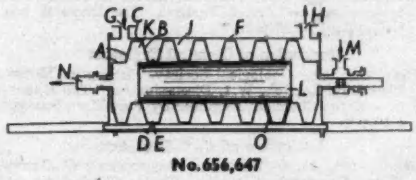
drawal of the latch out of engagement with the ratchet. This withdrawal can be effected only by pneumatic power. A cylinder *E* formed within the base of the lamp, is fitted with a freely sliding piston *F*, the upper end of which bears against one end of a pivoted rocker *G*, the other end of which engages with a notch *H* cut in the side of the latch *C*. A cup-shaped depression *J* in the side of the lamp base forms the end of a small air passage leading to the base of the cylinder. By applying air pressure to the cylinder through this air passage the piston is forced upwards against the rocker, the other end of which presses the latch downwards against the spring pressure. If the air pressure applied is sufficiently great, the latch moves downwards out of engagement with ratchet and the two parts of the lamp may be unscrewed from one another. The spring strength and the cross-sectional area of the cylinder are so calculated that the pressure required to unlock the lamp is higher than is available in the mine, and only obtainable from equipment installed for the purpose in the lamp room. Hand appliances for applying compressed air to the locking device are also shown in the specification.—*September* 5, 1951.

HEAT EXCHANGERS

656,647. March 25, 1948.—Heat Exchangers, Liquid Conveyors and Condensers, Lambertus Hendrik de Langen, Rotterdamscheweg 99, Delft, Holland.

The invention provides a heat exchanger which can also serve as a conveyor of liquids or as a condenser. Referring to the drawing, a channel-shaped strip having side walls *A* and *B*, a bottom *C*, and side flanges *D* and *E*, is wound helically, so that the side walls define helicoidal surfaces. The side flanges are afterwards connected together. In order to produce a closed heat exchange system, a casing *F* encloses the outside of the helically wound strip. In the space between this casing



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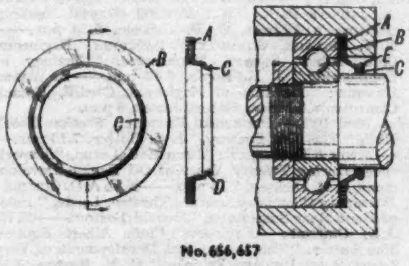
and the outside of the strip, liquid or gas is fed in through the inlet *G* and discharged through the outlet *H* at the end of the casing. When a liquid is to be cooled it is fed through the helicoidal passage *J*, while on the other side, that is to say, the inside of the helicoidal passage *K* as formed, the cooling medium is supplied. The apparatus is provided with a core *L*, on which the base of the strip is supported. In this way two long passages, *J* and *K*, of almost equal volume are formed and a liquid or gas can be fed into the passage *J* through the inlet *M* and discharged from the passage through the outlet *N*, the liquid or gas flowing in an opposite direction to the liquid or gas in the passage *K*. The woundstrip assembly is rotated, whereby the liquids fed in at *M* and *G* are caused to be conveyed through the helicoidal passages to the outlets.—*August* 29, 1951.

SHAFT GLANDS AND SEALS

656,657. May 3, 1948.—Oil Sealing Rings, Turner Brothers Asbestos Company, Ltd., Spotland, Rochdale, Lancashire, and Dudley Mortimer Maddox, of the company's address.

Referring to the drawings, the upper view shows an end elevation and a cross sectional view of an oil seal constructed in accordance with the invention, while the lower view shows the oil seal in a bearing housing. It will be seen that a base ring is formed by a core ring *A* of resinated asbestos enclosed within a skin *B* of oil resisting synthetic rubber. The flexible sealing element *C* is made integral with the skin and has a peripheral groove *D*



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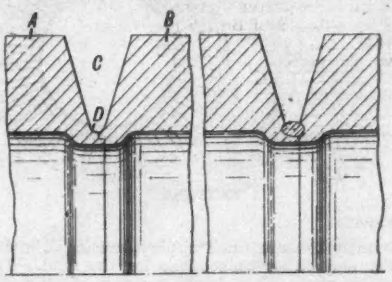
to receive a girdle or garter spring *E*, which holds the flexible part in intimate contact with the shaft. The diameter of the base ring of the seal is slightly less than the bore of the housing, so that on assembly the flexible element, with the garter spring around it, can ride freely on the shaft, which ensures correct action between the lip of the sealing element and the shaft without straining the element. The seal projects into the housing clearance around the shaft such clearance being increased to accommodate the sealing element. The improved seal eliminates the need for a deep housing, for the depth of the base ring need not be more than a fraction of an inch. The method of construction can be readily adapted to the various types of seal.—*August* 29, 1951.

METALLURGY

656,696. November 8, 1948.—Welded Joints, Hadfields, Ltd., Eric Winearls Colbeck, John Rhynas Rait and Daniel William Adams, all of East Hecla Works, Sheffield, 9.

The object of the invention is to enable a butt joint to be made without involving root dressing and rectification. As shown in the first drawing, the facing ends of the two tubes *A* and *B* have weld faces machined on them forming a tapering welding gap *C*, bounded at the inner or narrow end by a smoothly curved root *D*. Beyond the



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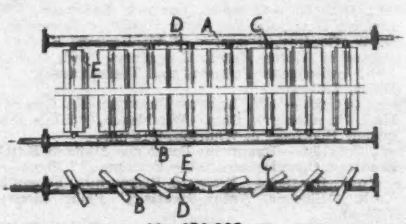
root end of the gap *C*, the two tubes have their facing ends formed with a stepped or double spigot, as indicated, so that they can be accurately and positively aligned. The first welding pass is made in the gap *C* at the root *D*. For this pass an arc welding electrode having deep penetrative characteristics should be used so that a large part of the resultant deposit of weld metal lies radially inwards from the root *D*. As shown in the second drawing, the welding is then continued in the usual way by successive passes until the gap is filled. For the passes after the first, the electrode used is chosen according to particular requirements and may or may not have deep penetrative characteristics.—*August* 29, 1951.

MISCELLANEOUS

656,892. February 27, 1948.—Heat Radiators, The Sturtevant Engineering Company, Ltd., of Southern House, Cannon Street, London, E.C.4, and Maurice Frederick Stevens, of the company's address.

Referring to the drawing, heating fluid is circulated through a pipe system, which comprises a pair of horizontal header tubes *A* and *B*, one above the other, and vertical tubes *C*, extending between the header tubes. Each of the vertical tubes carries a rectangular radiating plate *D*, mounted so as to be rotatable about the tube. Each of the plates is in good heat-conducting contact with its tube. The front face of the plate is exposed and the rear face is covered by heat



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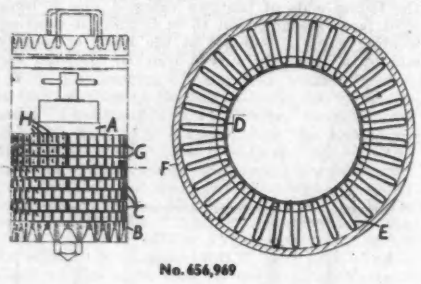
insulating material *E*. The dimensions are such that when all the plates are angularly adjusted to lie in the same plane with their front faces facing the same way, the faces form a substantially continuous radiating surface filling the space between the header tubes. By angularly adjusting the plates selectively about the tubes, as shown in the drawing, the heat rays from the front surfaces may be directed in all the different directions necessary to cover the whole of the working zone. A modification in which the upper and lower headers are curved is also illustrated.—*September* 5, 1951.

656,960. January 19, 1949.—Magnetic Separators, Philips Electrical, Ltd., Spencer House, South Place, Finsbury, London, E.C.2, Charles William Verity Davis, Century House, Shaftesbury Avenue, London, W.C.2, Herbert Wilfred Westwood, 211, Crookston Road, Eltham Park, London, S.E.9, and William Charles Claude Westwood, 148, Ankerdine Crescent, Shooters Hill, London, S.E.18.

The magnetic separator comprises a hollow, non-magnetic casing *A*, within which is housed a

permanent magnet of bar form or a permanent magnet assembly composed of more than one magnet. The magnets may be retained within the casing by a central bolt and nut, which also retains a pole piece *B* of magnetisable material in position at one end of the casing. The disc filter elements *C*, carried by the casing, comprise an annular core *D* of non-magnetic material, such as brass, having a channel section and a number of fin-like extensions *E* of magnetic material. The core is located relatively to the casing by a key and groove, the whole



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assembly being retained within a housing *F* having inlet and outlet connections for the fluid. The fins are produced by bending a strip of magnetisable material into a series of alternate jointed "U's" and inverted "V's," as shown in the section. A predetermined length of this zig-zag strip is bent to substantially circular form and the ring thus formed is sprung on to the core *D*, the natural resilience of the material holding it firmly in the channel section. The axial length of the fins is less than the overall axial length of the core on which they are mounted so that when a number of elements are assembled in a stack gaps *G* are provided between the fins of adjacent elements. The fins may be arranged in line or in staggered relation. The fluid from which the magnetic particles are to be separated flows through the separator in a number of parallel paths, as indicated by the arrows *H*, the particles being trapped in the gaps between the fins out of the path of the flow.—*September 5, 1951.*

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Association of Supervising Electrical Engineers

Mon., Oct. 8th.—CENTRAL LONDON BRANCH: St. Ermin's Hotel, Caxton Street, S.W.1, "Television," G. W. Godfrey, 7 p.m.——N.W. LONDON BRANCH: Prince of Wales Hotel, Kingsbury Road, N.W.9, "Oil Switchgear Failures and Their Causes," N. Elliot, 7.45 p.m.

Tues., Oct. 9th.—S.W. LONDON BRANCH: St. George's Hall, St. George's Road, Wimbledon, "High Frequency Heating," J. Wharton, 8.15 p.m.

Wed., Oct. 10th.—BRADFORD BRANCH: Midland Hotel, Bradford, Open Debate, "Any Problems," 7.30 p.m.——YORK BRANCH: Feasgate Restaurant, Feasgate, York, "Electric Water Heating," Philip Honey, 7.30 p.m.

Fri., Oct. 12th.—BRISTOL BRANCH: Grand Hotel, Bristol, "Energy from the Atom," A. F. Possnett, 7.30 p.m.——NOTTINGHAM BRANCH: Electricity Showrooms, Smithy Row, Nottingham, "Relays and Remote Control," W. L. Stern, 7.30 p.m.

Illuminating Engineering Society

To-day, Oct. 5th.—BATH AND BRISTOL CENTRE: S.W. Electricity Board, Old Bridge, Bath, "Stage Lighting," J. W. Strange, 7 p.m.——HUDDERSFIELD GROUP: Electricity Showroom, Market Street, Huddersfield, "Lighting for High Speed Photography and Cinematography," J. Hadland, 7.15 p.m.

Tues., Oct. 9th.—Royal Institution, Albemarle Street, London, W.1, Presidential Address, J. G. Holmes, 6 p.m.

Wed., Oct. 10th.—EDINBURGH CENTRE: Welfare Club Hall, Lighting and Cleansing Department, 357, High Street, Edinburgh, "Lighting for the Prevention of Industrial Accidents," E. W. Murray, 7 p.m.

Thurs., Oct. 11th.—GLASGOW CENTRE: Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank Crescent, Glasgow, "Lighting for the Prevention of Industrial Accidents," E. W. Murray, 6.30 p.m.——MANCHESTER CENTRE: Town Hall Extension, Manchester, Presidential Address, J. G. Holmes, 6 p.m.

Fri., Oct. 12th.—BIRMINGHAM CENTRE: Imperial Hotel, Temple Street, Birmingham, Chairman's Address, R. A. Lovell, 6 p.m.

Institute of British Foundrymen

Sat., Oct. 6th.—WALES AND MONMOUTH BRANCH: Engineer's Institute, Cardiff, Film Display, including illustrations of Non-Ferrous Productivity Team's Visit and Report, 6 p.m.

Tues., Oct. 9th.—SLOUGH SECTION: High Duty Alloys, Ltd., Slough, "The Running and Feeding of Castings," H. B. Farmer, 7.30 p.m.

Fri., Oct. 12th.—LONDON BRANCH: Second Annual National Works Visits Day.

Institute of Marine Engineers

Tues., Oct. 9th.—85/88, The Minories, London, E.C.3, "Refractory Materials for Marine Boilers," F. H. Clews, 5.30 p.m.

Thurs., Oct. 11th.—Technical College, Acton, "Electric Propulsion of Ships," M. W. T. Rees and G. J. Tuke, 7 p.m.

Institute of Metals

Mon., Oct. 8th.—SCOTTISH LOCAL SECTION: Visit to the Works of Henry Wiggin and Co., Ltd., Thornliebank.

Tues., Oct 9th.—S. WALES LOCAL SECTION: University College, Metallurgy Department, Singleton Park, Swansea, "Metallurgical Problems of Atomic Energy," H. M. Finniston, 6.30 p.m.

Institute of Navigation

Fri., Oct. 19th.—Royal Geographical Society, 1, Kensington Gore, S.W.7, Presidential Address, "Navigation and the Shipping Industry," Sir Robert Watson-Watt, 3 p.m.

Institute of Petroleum

Wed., Oct. 10th.—26, Portland Place, London, W.1, Symposium on "Acid Sludge: Its Disposal and Utilisation," 5.30 p.m.

Institution of Chemical Engineers

Tues., Oct. 9th.—Geological Society, Burlington House, Piccadilly, London, W.1, Discussion on "The Education of the Chemical Engineer by Part-Time Study," 5.30 p.m.

Institution of Civil Engineers

Thurs., Oct. 11th.—MIDLANDS ASSOCIATION: James Watt Memorial Institute, Great Charles Street, Birmingham, Chairman's Address, M. R. Vincent Davies, 6.30 p.m.

Institution of Electrical Engineers

Mon., Oct. 8th.—S. MIDLAND CENTRE: Grand Hotel, Birmingham, Chairman's Address, Annual General Meeting and Conversazione, 6 p.m.

Tues., Oct. 9th.—N. MIDLAND CENTRE: British Electricity Authority, 1, Whitehall Roads, Leeds, 1, Chairman's Address, E. C. Walton, 6.30 p.m.——E. MIDLAND CENTRE: The College, Loughborough, Annual General Meeting and Chairman's Address, A. W. Hirst, 7 p.m.——SCOTTISH CENTRE: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, Chairman's Address, 7 p.m.

Thurs., Oct. 11th.—Savoy Place, Victoria Embankment, W.C.2, Presidential Address, Sir John Hacking, 5.30 p.m.

Institution of Engineering Draughtsmen and Designers

Mon., Oct. 8th.—University College, London University, Gower Street, W.C.1, "The Use of Tin-Based Substitutes for Metals and Alloys in Short Supply," 7 p.m.

Institution of Engineers and Shipbuilders in Scotland

Tues., Oct. 9th.—39, Elmbank Crescent, Glasgow, Presidential Address, Sir Andrew McCance, 6.30 p.m.

Institution of Incorporated Plant Engineers

To-day, to Sun., Oct. 5th to 7th.—Hotel Hydro, Dunblane, Perthshire, Scottish Conference.

Institution of Mechanical Engineers

To-day, Oct. 5th.—N.E. BRANCH, GRADUATES' SECTION: Northern Gas Board Showrooms, Grainger Street, Newcastle upon Tyne, "Materials Testing," M. Milne, 7 p.m.——SOUTHERN BRANCH, GRADUATES' SECTION: Municipal College, Brighton, Chairman's Address, R. P. Scott, 7 p.m.

Tues., Oct. 9th.—AUTOMOBILE DIVISION: Storey's Gate, St. James's Park, S.W.1, Annual General Meeting, Chairman's Address, C. B. Dicksee, 5.30 p.m.——N.W. BRANCH, GRADUATES' SECTION: Engineers' Club, Albert Square, Manchester, "Analogy in Engineering," J. K. Royle, 6.45 p.m.——S. WALES BRANCH: Institute of Engineers, Cardiff, Branch Chairman's Address, Robert James, 6 p.m.

Wed., Oct. 10th.—YORKSHIRE BRANCH: Station Hotel, Hull, "The New Factory," J. G. Bulger, 7.15 p.m.——LUTON A.D. CENTRE: Town Hall, Luton, "Experiences During Twenty Years of Oil Engine Development, C. B. Dicksee, 7.15 p.m.——N.E. A.D. CENTRE: University Chemistry Lecture Theatre, Leeds, "Independent Rear Suspension," Donald Bastow.——N.W. A.D. CENTRE: Engineers' Club, Albert Square, Manchester, "The Design and Development of Very Large Road Haulage Vehicles," C. E. Burton, 7.15 p.m.——SOUTHERN BRANCH: University College, Southampton, "Marine Boiler Deterioration," L. G. Slater and N. L. Parr, 7 p.m.

Thurs., Oct. 11th.—SCOTTISH BRANCH: Royal Technical College, George Street, Glasgow, "Methods of Stress Analysis," Robert M. Kenedi, 7.30 p.m.

Fri., Oct. 12th.—N.E. BRANCH, GRADUATES' SECTION: Head, Wrightson and Co., Ltd., Teesdale Ironworks, Thornaby-on-Tees, Stockton, "Materials Testing," M. Milne, 7 p.m.

Institution of Production Engineers

To-day, Oct. 5th.—WEST WALES SECTION: Central Library, Alexandra Road, Swansea, "History and Development of the Tube Industry," W. Goldsworthy, 7.30 p.m.

Mon., Oct. 8th.—HALIFAX SENIOR AND GRADUATE BRANCH: White Swan Hotel, Halifax, "Tracer Controlled Machine Tools," P. K. Eisner, 7.15 p.m.——YORKSHIRE BRANCH: Hotel Metropole, Leeds, "Some Aspects of Materials Handling in Industry in the U.S.A.," E. G. Taylor, 7 p.m.

Tues., Oct. 9th.—BIRMINGHAM GRADUATE BRANCH: James Watt Memorial Institute, Great Charles Street, Birmingham, "The Production of a High Performance British Sports Car (The XK120 'Jaguar')," J. Silver, 7 p.m.

Wed., Oct. 10th.—EASTERN COUNTIES BRANCH: Suckling House, St. Andrews Plain, Norwich, "Valid Incentives," E. C. Gordon England, 7.30 p.m.——LIVERPOOL BRANCH: N.W. Gas Board, Radiant House, Bold Street, Liverpool, "Work Assignment and Incentive Payment on Semi-Automatic Machines," T. F. O'Connor, 7.15 p.m.

Institution of the Rubber Industry

Mon., Oct. 8th.—MIDLAND SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham, "Some Factors Influencing the Road Wear of Tyres," R. D. Stiehler, 6.45 p.m.

Institution of Structural Engineers

Thurs., Oct. 11th.—11, Upper Belgrave Street, London, S.W.1, Presidential Address, Walter C. Andrews, 5.55 p.m.

Junior Institution of Engineers

Mon., Oct. 8th.—N.W. SECTION: Manchester Geographical Society, 16, St. Mary's Parsonage, Manchester, "Automatic Lathes," H. Spencer Smith, 7.30 p.m.

Fri., Oct. 12th.—39, Victoria Street, Westminster, S.W.1, "Gas Distribution Engineering," C. D. Shann, 6.30 p.m.

Liverpool Engineering Society

Wed., Oct. 10th.—9, The Temple, 24, Dale Street, Liverpool, "The Technical Education of the Part-Time Engineering Student," R. H. Grundy, 6 p.m.

Liverpool Joint Chemistry Committee

Thurs., Oct. 11th.—Old Council Chamber, Town Hall, Preston, "Chemical Engineering," Sir Christopher Hinton, 7.30 p.m.

Liverpool Metallurgical Society

Fri., Oct. 12th.—Electricity Service Centre, Whitechapel, Liverpool, "The Problem of the High Temperature Oxidation of Metals," A. Preece.

Newcomen Society

Wed., Oct. 10th.—Science Museum, Exhibition Road, S.W.7, "Chapman's Locomotives, 1812–1815," E. A. Forward, 5.30 p.m.

Stephenson Locomotive Society

Sat., Oct. 6th.—Special Train Tour of N. London and Southern Junction Lines, leaving Kensington (Olympia) 2.30 p.m.——N.W. AREA: Visit to Crewe Works and Locomotive Sheds, 9.30 a.m. and 2 p.m.

Catalogues

RANSOMES AND RAPIER, Ltd., Waterside Works, Ipswich.—Booklet describing the 410 ¾ cubic yard Excavator.

ABINGDON KING DICK, Ltd., Abingdon Works, King's Road, Tyseley, Birmingham, 11.—Catalogue of Hand Tools.

ENGLISH ELECTRIC COMPANY, Ltd., Instrument Works, Stafford.—Publication describing Polyphase Watt-Hour Meters.

JAMES BEERSFORD AND SON, Ltd., Marston Green, Birmingham, 33. Brochure entitled "Pumps and Pumping, Past and Present."

BRITISH JEFFREY-DIAMOND, Ltd., Stennard Works, Wakefield, Yorks.—Folder No. 1484, giving details of the 35 BB Shortwall Coal Cutter.

BLICK TIME RECORDERS, Ltd., 188/190, Grays Inn Road, London, W.C.1.—Leaflet describing "Man-Hunter" Staff Locating System.

STANDARD TELEPHONES AND CABLES, Ltd., Connaught House, Aldwych, London, W.C.2.—Booklet dealing with miniature direct-wire systems.

CRAWFORD AND CO. (TOTTENHAM), Ltd., Tower Hill Works, Witney, Oxfordshire.—Booklet dealing with the "Trugrip" Collet Chuck and accessories.

BRITISH VAPOUR BLAST, Ltd., Central Chambers, Market Square, Wellington, Salop.—Brochures describing the Vapour Blast system of liquid honing.

STURTEVANT ENGINEERING COMPANY, Ltd., Southern House, Cannon Street, London, E.C.4.—Publication No. 4705, brick, tile and heavy clayware drying.

SPANNER BOILERS, Ltd., 10, Hopton Road, London, S.W.16.—Brochure No. 14, illustrating "Swirlyflo" Automatic Waste Heat Installations for Marine Work.

MORGAN CRUCIBLE COMPANY, Ltd., Battersea Church Road, London, S.W.11.—Booklet ZD18, dealing with "Morganite Brushes: Mounting and Maintenance."

KEITH BLACKMAN, Ltd., Mill Mead Road, London, N.17.—Publications dealing with W1100 wet type unit system of dust collection, and the 16in air circulator.

MOND NICKEL COMPANY, Ltd., Sunderland House, Curzon Street, London, W.1.—Publication entitled "The Mechanical Properties of Nickel Alloy Steels."

KESTNER EVAPORATOR AND ENGINEERING COMPANY, Ltd., 5, Grosvenor Gardens, Westminster, London, S.W.1.—Leaflet No. 26, describing pumps for handling corrosive liquids.